

Conference Proceedings

Water Security and Climate Change Adaptability

Policy Perspective & Proceedings of
7th International Water Conference
29-30 December 2022 - Islamabad



7TH INTERNATIONAL WATER CONFERENCE

29th – 30th December 2022

Islamabad



Riphah Institute of Public Policy

RIPHAH INTERNATIONAL UNIVERSITY

www.riphah.edu.pk

ISBN 978-969-23348-9-1

ISBN 978-969-23348-9-1

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Message of the Chancellor Riphah International University, Islamabad



Mr. Hassan Muhammad Khan
Chancellor
Riphah International University

Water security in Pakistan is a major concern due to the country's increasing population and limited water resources. Climate change is exacerbating the situation by causing more frequent droughts and floods, which can lead to water shortages and damage to infrastructure. In addition, melting glaciers in the Himalayas are causing changes in the timing and volume of water flows, which can disrupt irrigation systems and hydroelectric power generation. In 2022, we have witnessed major flash floods creating a catastrophic situation in one third of Pakistan. Deliberations and proceedings of 7th International Water Conference will sensitize the related stakeholders to take some measures to avoid the same situation in future.

The state of affairs are not very bad in all respects as some institutions in Pakistan

have taken number of initiatives and measures to improve water security and adapt to the impacts of climate change. These includes building new dams and reservoirs, improving irrigation systems, implementing conservation and efficiency measures, and addressing water quality issues. In addition, the government is investing in the development of alternative sources of water such as rainwater harvesting and desalination. Another area of focus is the development of early warning systems and disaster risk management plans to help communities better prepare for and respond to floods and droughts. Various scientists, academicians, scholars, agriculture experts are also working to reinforce the resilience of its agriculture sector by promoting drought-resistant crops and irrigation methods. However, a holistic approach is required with an effective collaboration of all the water actors to improve the national water productivity.

To achieve true change, all voices and perspectives are needed and 7IWC has provided a dynamic forum not only in highlighting the critical issues related to water sector and climate change but viable recommendations to address the same.

Message of the Country Director WaterAid





Mr. Arif Jabbar Khan, Country Director, WaterAid, Pakistan

Water issues and climate change are two of the most imperative environmental challenges facing the world today. The effects of climate change are expected to exacerbate issues related to water quantity and quality, which in turn will have far-reaching consequences for people and ecosystems alike. Pakistan is particularly vulnerable to the impacts of climate change and water scarcity, with many areas of the country already experiencing severe water shortages and increasing temperatures, besides climate induced hazards such as floods, droughts, heatwaves etc.

In many parts of the world, including Pakistan, climate change is leading to more intense and erratic rainfall, which can result in both flooding and drought as well as leading to changes in the timing and amount of water available for agriculture and human consumption. Climate change is also contributing to the melting of glaciers and snowpacks, which are major sources of freshwater in many parts of the world, including Pakistan. With inflows expected to become more variable in the coming years, the severity of climatic extremities will become more pronounced, driving up water demands in addition to the increase in demand

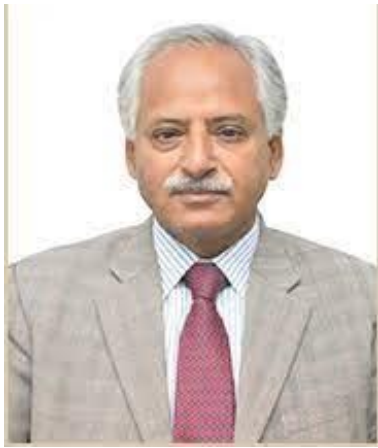
from unchecked population growth and urbanization. Contamination and over extraction of groundwater resources is also disturbing the water calculus and pushing the country towards a critical demand-supply gap. Besides the impact on availability and access to safe drinking water, water scarcity will also affect sanitation and hygiene practices of communities, thereby impacting public health. Studies and experience have shown that women and girls, persons with disabilities and other marginalized groups are disproportionately affected by limited availability of and access to water sources.

To address these challenges, urgent actions are required including a reduction in greenhouse gas emissions, adapting water infrastructure (for drinking water, agriculture etc) to the effects of climate change and raising awareness among the local populace on the significance of water conservation and protection of water sources, especially groundwater. Additionally, international cooperation will be necessary to provide technical and financial support to the people and Government of Pakistan to undertake mitigation and adaptation measures.

I hope the proceedings of 7th IWC will help and guide academicians, researchers, policymakers, and students, to play their part in water protection and conservation more effectively.



Message from Chairman PCRWR



Dr Muhammad Ashraf
Chairman PCRWR

Water is an essential part of our life and it plays a key role in sustainable development on the planet earth. Climate change is causing an unprecedented strain on our water resources. Rising temperatures, changing precipitation patterns, and more frequent extreme weather events are disrupting water availability and quality across the globe. As a result, vulnerable communities are suffering from water scarcity, economic hardship, and social instability. Therefore, Water security and climate change adaptability are interrelated and must be addressed in tandem to ensure a sustainable future for generations to come.

Water security is not just a matter of ensuring access to clean drinking water. It is also about ensuring that we manage water resources sustainably across all sectors, including agriculture, industry, domestic use and ecosystem. This is particularly important in the water-stressed regions like Pakistan, where a proactive approach is imperative in implementing adaptive strategies to minimize the impact of climate change.

We need to address water and climate issues on top priority and to develop a comprehensive strategy which may incorporate innovative solutions and collaborative efforts. There is a need to prioritize the implementation of sustainable water management practices, including water conservation, efficiency, and reuse, and invest in advanced efficient technologies (wastewater treatment, rainwater harvesting, and desalination etc.) that support these practices. An integrated effort is required at all levels to build resilience in vulnerable communities, invest in early warning systems, and establish contingency plans to mitigate the impact of extreme weather events, such as droughts and floods.

In short, we have a responsibility to act with knowing-doing approach to address the challenges related to Pakistan's water security and climate change adaptability. The seventh international conference has provided a platform for deliberations to bring forward the ideas to address these challenges and to provide plausible recommendations for implementation by water sector stakeholders including policy and decision makers. I hope the proceedings of 7IWC will help and guide academics, researchers, policy actors and students to carry out future actions accordingly.



Message from Chairman Federal Flood Commission



Dr Ahmed Kamal, Chairman
Federal Flood Commission

I hope the 7th International Conference & its proceedings would add value to the policy recommendations and formulation of the strategies on the subject. Water management and climate change adaptability are critical issues that require urgent attention, particularly considering the recent floods in Pakistan. Climate change has led to more frequent and intense weather events such as flooding, which can have visible devastating consequences for the communities and infrastructure has been manifested by floods of 2022. Effective water management practices are crucial to mitigate the impacts of such events and build climate change adaptability. Impacts of the 2022 floods on Pakistan are phenomenal, unprecedented, and historically callused that caused widespread human casualties, damage to infrastructure, including roads, bridges, as well as severe loss to 17 economic sectors of national importance.

There is dire need for adopting better water management strategies specifically in the agriculture sector including effective water management practices and adequate drainage systems, more robust river flowmetry, flood protection infrastructure maintenance as well as addressing the encroachment issue in the floodplains through effective enforcement of flood plain act.

A multi-pronged approach that focuses on both mitigation and adaptation is prerequisite. The mitigation efforts should aim to reduce greenhouse gas emissions and limit the effects of climate change and the adaptation measures should focus on building resilience to the impacts of climate change and improving water management practices adequately supported with well thought out water conservation strategies. The construction of levees, dams, and other infrastructure can help to protect communities from flooding and ensure the efficient distribution of water resources.

It is imperative that policymakers and water stakeholders to work together like hand in glove to develop and implement comprehensive climate change centric water resources development and management plans in order to tackle water resource system management issues and to promote sustainability and resilience.



Message of the Director Riphah Institute of Public Policy



Prof. Dr Rashid Aftab
Director
Riphah Institute of Public Policy

As you delve into this book on the 7th International water conference proceedings, I hope you will be inspired to join the ongoing conversation on these critical topics. The world is facing multiple challenges related to water security, as a result of climate change, growing populations, and expanding urbanization.

Floods and other natural disasters, compounded by the effects of climate change, are exacerbating the calamity, and creating even greater challenges for Pakistan. It is imperative collective efforts to find solutions that will ensure water security for all, while mitigating the impacts of floods and other extreme events.

This conference brought together experts from various fields to explore the challenges and opportunities and suggest the futuristic approach associated with Water security, Maritime Sector, GLOFs, Islamic Perspective of water governance and climate change. The discussions and presentations contained within these proceedings represent a valuable contribution to the ongoing dialogue on these crucial issues.

I also would like to offer to all, the platform of International Water Conference to exchange ideas, share best practices, and collaborate on meaningful course of action. To pool collective effort, we can secure a future of coming generations where water is abundant, accessible, and managed in a sustainable manner.

I hope that this book of water proceedings will serve as a catalyst for further action and collaboration, leading to a more sustainable future for all.



TABLE OF CONTENTS

EXECUTIVE SUMMARY OF 7 TH IWC -----	5
THEME 1-----	7
CLIMATE CHANGE AND MARITIME SECURITY-----	7
CLIMATE CHANGE – A POTENTIAL THREAT TO MARITIME SECURITY8	
DIMENSIONS OF CLIMATE CHANGE: HORIZONTAL AND VERTICAL -----	9
DEHYDRATION/ FLOODING- DIALECTICAL HAZARD: AN INQUIRY INTO PAKISTAN AS A UNIQUE CASE -----	10
REMOVAL OF HEAVY METALS THROUGH MAGNETIC FISH SCALE BIO-ADSORBENT FROM AQUEOUS MEDIA-----	11
MALARIA DYNAMICS IN CHANGING CLIMATE OF PAKISTAN -----	12
DESIGN AND FABRICATION OF ELECTROCHEMICAL AMINE REGENERATION CELL FOR CARBON DIOXIDE CAPTURE -----	13
FRESHWATER MICROALGAE AS BIO STIMULANT FOR RICE (<i>ORYZA SATIVA L.</i>) CROP PRODUCTION: A SUSTAINABLE GREEN AGRICULTURE-----	14
BIODEGRADABLE SANITARY NAPKIN AS BEST REPLACEMENT OF CHEMICAL AND PLASTIC POLLUTION: A CALL FOR GLOBAL ACTION -----	15
ASSESSMENT OF WATER SAVING, AND YIELD OF WHEAT PLANTED ON RIDGES AND FLAT BED UNDER SOIL SALINITY -----	16
THE GAUGING OF AQUIFERS FLUCTUATION AND GROUNDWATER ECONOMY IN QUETTA VALLEY, BALUCHISTAN, PAKISTAN -----	17
EXPLORATION OF GROUNDWATER RESOURCES FOR FUTURE SETTLEMENT OF POPULATION IN NORTHERN AREAS OF QUETTA VALLEY THROUGH VERTICAL ELECTRICAL SOUNDING -----	27
HYDRO-DIPLOMACY AND THE PROSPECTS OF ENVIRONMENTAL -----	33
PEACE BUILDING BETWEEN PAKISTAN AND INDIA -----	33
MICROALGAL-BASED HYDROCHAR FOR THE REMOVAL OF FLUORIDE FROM GROUNDWATER -	34
ANALYSIS OF THUNDERSTORM ACTIVITY OVER PAKISTAN IN RECENT YEARS-----	39
SYNTHESIS OF ROOM TEMPERATURE IONIC LIQUIDS BASED ON IMIDAZOLIUM CATION AND THEIR POTENTIAL APPLICATION AS EXTRACTANTS OF SULFUR-COMPOUNDS FROM COAL --	40
WATER CRISES AND ADAPTATION GOVERNANCE: A CASE OF AGRICULTURE SECTOR FROM PAKISTAN-----	41
A SMART FLOATING WASTE COLLECTOR FOR SUSTAINABILITY OF AQUATIC BIODIVERSITY--	42
RAINWATER HARVESTING POTENTIAL SITES AT MARGALLA HILLS NATIONAL PARK -----	43
CHLORINE DISINFECTION FOR REMOVAL OF BIOFILMS IN DRINKING WATER DISTRIBUTION SYSTEMS -----	44

SPATIAL CROP MANAGEMENT USING REMOTELY SENSED SOIL MOISTURE CONTENTS ESTIMATION UNDER SEMI-ARID CONDITION -----	45
 THEME 2: -----	 58
 GLACIAL LAKE OUTBURST FLOOD (GLOF) -----	 59
 GLACIAL LAKE OUTBURST FLOODS: IMPACT ON THE ENVIRONMENT AND SOCIOECONOMIC CONDITIONS OF HUNZA -----	 60
IMPACTS OF CLIMATE CHANGE AND GLOF ON THE LIVELIHOOD OF COMMUNITIES IN KARAKORUM RANGE OF BALTIKISTAN -----	61
GLACIAL LAKE OUTBURST FLOOD IN PAKISTAN: A SYSTEM THINKING BASED RISK MANAGEMENT APPROACH -----	62
GLACIAL LAKE OUTBURST FLOODS: IN PRETEXT TO RECENT UNPRECEDENTED FLOODS IN PAKISTAN -----	63
PROBABILITY OF GLACIERS LAKES OUTBURST FLOOD IN HUNZA, PAKISTAN -----	76
GLACIAL LAKE OUTBURST FLOODS AND CLIMATE CHANGE IN PAKISTAN -----	77
GEOPHYSICAL INVESTIGATION OF SUBSURFACE GLACIAL LAKE OUTBURST FLOOD LAKE DEVELOPMENT AT BINDOGOL VALLEY UNDER CHANGING CLIMATE, PAKISTAN -----	78
 THEME 3: -----	 79
 WATER POLLUTION & WASTEWATER MANAGEMENT -----	 79
 ANALYSIS OF SCHOOL BASED WASH (WATER SANITATION AND HEALTH SCIENCES) FACILITIES, IMPLICATIONS ON CHILDREN BEHAVIOR AND HEALTH COUPLED WITH POLICY FRAMEWORK FOR ENHANCING COGNITIVE LEARNING IN CHILDREN. -----	80
KINZ USING BROWN SEAWEED IRON OXIDE MODIFIED BIOCHAR -----	97
INNOVATIVE WAY OF DETECTING AND ANALYSIS OF FOODBORNE PATHOGENS VIA SMART DEVICES -----	97
EXPLORING TRADITIONAL WATER MANAGEMENT SYSTEM AND INVENTORY THROUGH GIS IN SKARDU TOWN (OLDING SKARDU) -----	110
WATER POLLUTION AND WATER WASTE MANAGEMENT BY -----	121
DEVELOPMENT OF TITANIUM DIOXIDE NANOPARTICLES (TiO ₂ NPs) BY SOL-GEL METHOD TO CONTROL PERSISTENCE ORGANIC POLLUTANT ATRAZINE FROM DRINKING WATER -----	129
IMPACT OF HAND WASHING PRACTICES USING EDUCATIONAL INTERVENTIONS ON ORPHAN CHILDREN OF SINDH. -----	134
WATER POLLUTION AND WASTEWATER MANAGEMENT -----	145
EFFICIENT BANANA PEEL-BASED BIO-SORBENT FOR ADSORPTIVE REMOVAL OF MOXIFLOXACIN -----	146
WATER QUALITY STATUS OF NATURAL SPRINGS AND SUPPLY WATER RESOURCES IN CITY BAGH, AJ&K -----	147
WATER QUALITY OF FILTERED WATER IN HOUSING SOCIETIES OF LAHORE AND ASSOCIATED HEALTH RISKS -----	148

FORMALDEHYDE REMOVAL FROM MEDIUM DENSITY FIBREBOARD EFFLUENT THROUGH ELECTROCOAGULATION -----	149
REMOVAL OF INDIGO CARMINE DYE USING NATURAL BIOSORBENT PREPARED FROM PRESS MUD -----	150
DEVELOPMENT OF INDIGENOUS ARSENIC TREATMENT UNIT FOR DRINKING WATER. -----	151
THE PROFILE OF TOTAL DISSOLVED SOLIDS AND ARSENIC OF GROUNDWATER, NEAR RIVER RAVI, LAHORE, PAKISTAN -----	152
PRODUCTION OF ORGANIC FERTILIZER BY RECYCLING OF SUGAR INDUSTRY WASTE -----	161
EFFECTS OF INDUSTRIAL EFFLUENTS ON PHYSICO-CHEMICAL AND NUTRITIONAL PARAMETERS OF MAIZE -----	162
OPTIMIZATION OF N: P & MG: P RATIO FOR STRUVITE RECOVERY FROM MOLASSES-BASED DISTILLERY SPENT WASH -----	163
A CRITICAL REVIEW OF TEXTILE DYE WASTEWATER TREATMENT PROCESSES -----	164
COMBINED ADSORPTION DISTILLATION TECHNIQUE TO TREAT RO MEMBRANE REJECT WATER -----	165
BIOCHEMICAL AND BIOCHAR TREATMENT OF SALINE SOIL FOR IMPROVING NUTRIENT-WATER-UPTAKE -----	20
CARBONIZATION AND ACTIVATION OF BANANA LEAVES FOR REMOVAL OF NI, PB, CR AND MIXED SOLUTION OF HEAVY METALS FROM WASTEWATER -----	28
IMPROVEMENT OF SOIL FERTILITY AND WATER CONSERVATION USING CO-COMPOSTED SOIL AMENDMENT -----	29
DRINKING WATER STORAGE MANAGEMENT AND HYGIENE PRACTICES IN KARIMABAD HUNZA (GILGIT-BALTISTAN). -----	30
ECO-INNOVATION FOR SUSTAINABLE GROWTH IN PAKISTAN: MARBLE SECTOR -----	31
WASTEWATER MANAGEMENT TO COPE WITH WATER POLLUTION AND WATER SCARCITY --	32
TANNERY WASTEWATER: A REVIEW OF ITS IMPACTS AND MITIGATION MEASURES IN PAKISTAN -----	33
BIOFOULING ORGANISMS IN THE COASTAL WATERS OF KARACHI WITH SPECIAL REFERENCE TO KARACHI HARBOUR -----	34
BIO-SENSING PLATFORM BASED ON GREEN SYNTHESIZED IRON OXIDE NANOPARTICLES FOR THE DETECTION OF WATERBORNE BACTERIAL PATHOGENS -----	35
GEOPHYSICAL INVESTIGATIONS AND PHYSIO-CHEMICAL ANALYSIS TO DELINEATE THE GROUNDWATER QUALITY IN THE CENTRAL PART OF BARI DOAB, PUNJAB, PAKISTAN -----	36
EFFECTS OF INDUSTRIAL EFFLUENTS ON PHYSICO-CHEMICAL AND NUTRITIONAL PARAMETERS OF MAIZE -----	37
-----	38
THEME4:-----	38
ISLAMIC PERSPECTIVE ON CLIMATE CHANGE, WATER POLLUTION & WATER MANAGEMENT -----	38
A STUDY OF WATER POLLUTION AND CONTEMPORARY REQUIREMENTS (IN THE CONTEXT OF ISLAMIC SHARIAH) -----	39
ABSTRACT -----	39
ISLAMIC PERSPECTIVE ON CLIMATE CHANGE, POLLUTION & WATER MANAGEMENT -----	50
GROWING PROBLEMS OF GLOBAL ENVIRONMENTAL POLLUTION -----	51
AND ISLAMIC TEACHINGS: AN ANALYTICAL STUDY -----	51

GLOBAL ENVIRONMENTAL CHALLENGES: AN ECO-THEOLOGICAL RESPONSE IN ISLAMIC PERSPECTIVE -----	52
WATER POLLUTION: CAUSES, DAMAGES, REMEDIES AND SOLUTIONS (IN THE LIGHT OF ISLAMIC TEACHINGS AND THE PROPHET'S ﷺ SEERAH) -----	53
آبی ماحول کا تحفظ اور احکامات: آیات و احادیث کے تناظر میں تحقیقی جائزہ -----	54
اسلامی تعلیمات کی روشنی میں تحقیقی مطالعہ -----	56
اہمیت و قلتِ آب اور ہماری ذمہ داری: اسلامی تعلیمات کی روشنی میں -----	57
REFERENCES -----	58
-----	73
7 TH IWC POLICY RECOMME-----	73
7 TH IWC POLICY RECOMMENDATIONS -----	73

Executive Summary of 7th IWC

Two days 7th International Water Conference (7IWC) – 2022 comprised of four thematic areas entitled “Water Security and Climate Change Adaptability” held at PCRWR on 29th and 30th December, 2022. It was organized by Faculty of Public Policy-Riphah International University with Pakistan Council of Research on Water Resources (PCRWR) and Water Aid in collaboration with Federal Flood Commission (FFC), University of Baltistan (UoB), Comsats University (CU), U.S.-Pakistan Center for Advanced Studies in Water (US-PCAS-W) at Mehran University. The conference provided a vibrant podium for the dissemination of scientific ideas of; scientists, academic scholars, researchers, Policy actors, Technocrats, Development sector, civil society members and progressive students, partners very enthusiastic and passionate to dig out the effective and viable scientific solutions, plans and intervention for the blue sustainability of Pakistan’s water sector and its relation to climate change.

Mr. Hassan Muhammad Khan, Chancellor, Riphah International University delivered in opening remarks the importance of water in terms of availability and the preservation of insufficient resources. Dr. Muhammad Ashraf, Chairman, PCRWR, Mr. Arif Jabbar Khan, Country Director, Water Aid and Mr. Ahmed Kamal, Chairman, Federal Flood Commission, Dr. Athar Hussain, CCRD, Dr. Ghulam Raza, University of Baltistan also spoke in the inaugural session.

The Speaker highlighted that blue regime has broader footsteps and it spread over diversified crossings in the world because it is linked with the phenomena of climate change which is an alarming issue at global level in general and Pakistan in particular. In the conference, the pivotal point of discussion was to take “**WATER AS OPPORTUNITY NOT A CHALLENGE**” so the hydro-sector can be taken as “**DEAL MAKERS NOT A DEAL BREAKER**”. The speaker emphasized that due to extreme Climate Change Scenarios, Security and reliability of maritime sector in term of economic efficacy, Glacial Lake Outburst Flood (GLOF), monitoring of Water Quality and existing hydro-protocols/standards need specific attentions by relying on the holistic, integrated nexus approach to bring together all vulnerable sectors of interest for community wellbeing Water in Pakistan’s context, water is an “**engine of national security**”, because affecting the normal citizens by putting the burden on the food industry (less agriculture productivity due to water- intensive practices), untenable energy utilization(non-availability of small and large dams to store wasted water in the Arabian Sea). The inclusive demand- driven model was proposed to be considering as operative way to buffer the impact of water as strategic acid.

The key areas addressed includes a) Inadequate Water Availability, b) Dependence on Single River System, c) Low Water Productivity, d) Overuse of Groundwater, e) Vulnerability of the country due to climate change, e) Limited access of the population to safe drinking water and f) Waste water management and treatment, f) Model for climate change in Pakistan, g) Factors associated with GLOF.

There is a need to re-manage the whole paradigm of water sector by evidence creation, echoing and modelling of available water resources in the hydro-sector. This can be done by focusing on applied and innovative water resources system, generation of real time data, plans of actions therefore it high time to revisit the blue strategy in the geo-economic approach and it should be re-orient with green nexus -to safe the country from an ultimate devastation.

The inaugural session was trailed by the 67 research articles presented by different scholars and scientists in accordance with the nature of following sub-themes of the conference.

Sub-Theme 1:

Climate Change & Maritime Security: Climate change is increasing the frequency and intensity of droughts, floods, and storms, and is raising the sea level with high temperature and changing rainfall pattern. The larger vulnerable segment of the society is facing socioeconomic stresses due to extreme climate, the complexities in finding solutions to reduce these stresses is challenging. There is a need for the adaptation of water resources to climate change at multiple levels (transboundary basin of rivers, lakes and aquifers). To mobilize all actors to achieve a common vision to face the climate change challenges. Further innovative model of climate governance, advanced system of carbon economic development and diplomacy following utilization scheme of maritime resources with investment on research and development may be account-far.

Sub-Theme 2:

Glacial Lake Outburst Flood (GLOF): Conservation strategy for urban flood management, scientific and reliable solution for water storage and long-term management schemes, survival of endangered species. Glaciers in Pakistan's northern mountain ranges (the Hindu Kush, Himalayas, and the Karakorum) are melting quickly due to rising temperatures. Total of 3,044 glacial lakes have formed in Gilgit-Baltistan (GB) and Khyber Pakhtunkhwa (KP). 33 glacial lakes have been identified as being vulnerable to dangerous glacial lake outburst floods (GLOF). GLOFs are abrupt events that can cause the release of millions of cubic meters of water and debris, resulting in the loss of lives, property, and livelihoods in isolated and impoverished mountain villages. Over 7.1 million people are vulnerable in GB and KP, with 26.7 % and 22 % of the population living below the poverty line, respectively. There is need to controlled breaching, construction of an outlet control structure, pumping water from the lake, making a tunnel through the moraine barriers well as early warning system may be installed at the vulnerable sites for floods from GLOF. In this regard scientific studies are desirable in these areas and other glacier related phenomena due to glacier dynamics.

Sub-Themes 3:

Water Pollution & Wastewater Management: Accessibility of safe drinking water, wastewater recycling for ecological balance, water quality monitoring system and renewable process of blue-green-cycling

Water pollution is one of the major threats to public health in Pakistan. Drinking water quality is poorly managed and monitored. Pakistan ranks at number 80 among 122 nations (drinking water parameters are not within the safe limits) regarding drinking water quality. Drinking water sources, both surface and groundwater are contaminated with coliforms, toxic metals and pesticides etc throughout the country.

Pakistan, with its alarming population growth and consequently increasing water requirement, generates huge volumes of wastewater (WW), Wastewater has nutrients, metal contaminants, and organic matter discharged from commercial, industrial, and residential areas. Without treatment, wastewater discharge deteriorates the quality of soil as water is used for irrigation (less than 1 % of wastewater is treated). Concrete steps to be undertaken for provision of safe drinking water to the citizens and to chalk out plan for converting wastewater as a source of recoverable valuable content. Further wastewater treatment plants are needed to provide clean water and further the potential of harnessing energy.

Sub – Theme 4:

Islamic Perspective on Climate Change: Water conservation strategies based on Islamic principles laws and theories, implementation system of equitable resources with hierarchical approach in Islamic society with climate mitigation plan are critical. It was articulated that water should be treated as most pivotal area of research. The findings of the outcomes should be embedded in the policy and planning of the country. There is an urgent need to alert the stakeholders to implement the action plan of water- food- energy



THEME 1

**CLIMATE CHANGE
AND
MARITIME SECURITY**

Climate Change – A Potential Threat to Maritime Security

Huzaifa Bin Abid*and Shahbaz Nasir Khan¹

Abstract

Climate change is a long-term change in the weather patterns and an increase in the average temperature of the globe. It is the reason for hotter temperatures, intense storms, and an increase in the number of droughts. Main cause of climate change is greenhouse gas emissions from natural and anthropogenic sources. The anthropogenic activities cause 1°C of global warming which will by 1.5°C by 2050. Climate change is the reason for sea level rise and ocean acidification. Coastal communities and economy which is based sources gained from the ocean are at risk due to climate change. Coastal lands are sinking due to rise of sea level. Increase in ocean acidification effects marine life, it makes an unsuitable environment for fishes to live. Ocean acidification effects economy of country who use fish as a source of food. Pakistan is facing maritime security issues intensively. However, Pakistan has almost negligible contribution to the anthropogenic source climate change i.e., less than 0.5% greenhouse gas emission. According to a report by National Institute of Oceanography Pakistan, some area of Karachi's Malir have already been sink, and by 2060, Thatta and Badin districts in Sindh will also sink due to this ongoing sea intrusion. Pakistan's marine life is also at risk which raise concern of food and social security. Climate change is also affecting costal tourism, shipping sector, ports, and harbor. Climate change can mitigate by using different methods and technique. Renewable energy source should be use instead of fossil fuel and coal for energy production. Plantation of more and more trees and use of different carbon sequestration method to cope up with current climate change. Government should give incentive or relaxation in taxes to industries who are environment friendly and adapting environment friendly techniques in their occupation.

Keywords: Climate change, marine pollution, mitigation measures

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Dimensions of Climate Change: Horizontal and Vertical

Arshad A. Narejo¹, M. Javed Sheikh¹, G. Mujtaba Khushk¹, Naeem A. Qureshi²²,

Abstract

In fact, climate change is an issue that has certain effects on agricultural production, human activities, health and may affect overall creature that are living on this earth. In Concerns over climatic imbalances on the globe attracted number of scholars to study on the issue but unfortunately researchers only perceived this matter as 'global warming' or 'vertical climate change'. However, it was perceived that the matter of climate shifting is also raised time to time by the local people and concurrently ignored by the related researchers. Targeting the matter of climate shifting or horizontal climate change, a study was conducted using secondary data of district Hyderabad, Sindh, in which temperature and rainfall intensity of two eras (1969-1989 and 2007-2018) were measured/compared. The quantified data were gathered 2007 to 2018, and was analyzed through Four alternative models namely, $SARIMA(1, 1, 2)_4$, $SARIMA(1, 1, 3)_4$, $SARIMA(2, 1, 1)_4$, and $SARIMA(3, 1, 1)_4$ models. The result of this study revealed that the ADF (*Augmented Dickey Fuller*) test used for checking the presence of unit root. The minimum of monthly temperature in the selected district is found (8.28 °C) whereas the maximum of temperature was attained at (42.32 °C). The mean of the temperature is (28.29 °C) with the variance of (135.49 °C). The large value of variance shows the greater variability in the temperature. $SARIMA(1,1,1)(1,1,1)_4$ model were found significant at conventional level of significance ($\alpha = 0.05$). Besides these model, the parameters of the remaining models were found to be non-significant (since t-values are less than 1.96) which indicates that these models contain redundant parameters and their selection leads us to non-parsimonious model. and $SARIMA(1,1,1)(1,1,1)_4$ is the most appropriate to model the temperature variations in the selected district, it is therefore recommended that concerned authorities/departments should revise the agricultural calendar. In addition, the study also validates that the concerns of local people are very much correct that the winter season has slightly shifted towards February resulting the spring season making shrink. On the other hand, no horizontal changes were recorded in summer temperature as compare to fifty years back but slight horizontal changes were revealed in summer rainfall over time. Hence, it is strongly recommended that the future studies on climate change could be clearly investigated keeping in mind the horizontal and vertical changes. And local calendars (agriculture and vacation) need to be revised to make appropriate with local climatic changes. **Key word:** Climate change, Climate Shifting

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Dehydration/ Flooding- dialectical hazard: An inquiry into Pakistan as a unique case

Asma Hussain³, Dr Waleed Rasool⁴

Abstract

The study explores the vulnerability of dehydration and overflowing as a dialectical, existential threat to Pakistan. The study mentions that assumptions had been changed from theoretical to real in Pakistan, particularly in 2022, when a shortage of water and overflowing worked in tandem multi-dimensionally. Acute dryness and precipitation are dialectical phenomena and unique characteristics in Pakistan's case as an underdeveloped country. Pakistan is facing acute challenges because the spring and summer monsoon is becoming wetter while fall and winter are bringing acute dehydration. It would serve as a mega challenge to Pakistan in coming years, therefore, not only for Pakistan's sustainable development and progress, but it carries multiple security implications as well. This dialectical hazard is in play at a time, therefore, Pakistan's intuitional capacity to cope with the vulnerability is also questionable, hence among developing countries, Pakistan is badly affected in 2022 despite the United Nations Intergovernmental Panel on climate change report had already predicted the rise of the temperature beyond 1.8-to-6.8-degree Celsius vis-a-vis requirements of water per person 900 Cubic feet to 2500 Cubic feet in Pakistan. The deficiency in green water and blue water is also an existential threat on the other side as Pakistan's population growth rate would make it overpopulated in 2035. This paper suggests a couple of policy guidelines when dialectical disaster works at the highest degree and the pace to address this vulnerability is slow. The study suggests that it is beyond the capacity of Pakistan and hence demands immediate global attention.

Key Points: Dialectical, dehydration, overflowing, Sustainable development, security

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Removal of Heavy Metals through Magnetic Fish Scale Bio-adsorbent from Aqueous Media

H, Muhammad Hussain, Sajjad Gul & Engr. Barkatullah Kandhro⁵

Abstract

The recent industrial development has emphasized a significant increase in the direct and indirect discharge of wastewater containing heavy metals into the environment, which is a severe environmental issue. Bio-adsorption is a reliable and cost-effective wastewater treatment technique for heavy metals. This study is done to determine the performance of magnetic fish scales as a bio-adsorbent to remove heavy metals from wastewater. For this purpose, the fish scale bio-adsorbent (FS) and magnetic fish scale bio-adsorbent (MFS) are used to remove copper, arsenic, and lead from aqueous media and have a comparative analysis. The batch experiments and column study techniques are applied with different dosages and contact times. Unlike FS bio-adsorbent, the use of MFS bio-adsorbent has increased the removal efficiency of arsenic from 18% to 64%, lead from 78% to 82%, and copper from 94 to 98% on 200 mg dose and 60 min contact time. Similarly, column study and batch experiment techniques are also compared. By applying the column study technique, the removal efficiency of arsenic is increased from 18 to 92 % and lead from 78 to 95% by using FS bio-adsorbent. The removal efficiency of arsenic is increased from 64 to 93%, and lead from 82 to 99 by using 10g MFS bio-adsorbent. The aqueous media samples were analyzed using Atomic Absorption Spectrometer. In Batch experiments, Cu was found to be more reactive to bio-adsorption than the other two metals and the column study technique was found to be a more effective technique for both FS and MFS for the removal of heavy metals. This study has shown the use of magnetic bio-adsorbent as a cost-effective, eco-friendly, innovative, and efficient method for the removal of heavy metals from wastewater.

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Malaria Dynamics in Changing Climate of Pakistan

Muhammad Shoaib⁶ and Athar Hussain⁷

Abstract

Climate change poses a serious hazard to the incidence, length of the transmission season, and spread of vector-borne illnesses. Malaria is an endemic disease; multiple studies are carried out to find the prevalence or detect the malaria endemic regions throughout the world. This study is carried out to determine the severity of the spatial and temporal transmission of malaria in Pakistan for which a dynamical malaria model Vector born disease community model of ICTP, TRIeste (VECTRI) is used. The impact of climate change on malaria transmission intensity is studied over the different areas of Pakistan. VECTRI considers temperature, precipitation, and population density. The Entomological Inoculation Rate (EIR) is used to measure the intensity of malaria transmission. For validation of the employed climate models, standardized anomaly of malaria cases in Pakistan is used to compare the observed cases count of the recent decade of 2010-2019. It has been demonstrated that during the months of August-October, Pakistan has the largest number of malaria cases during the months of August-October and the lowest cases occurring during the months of December-March. As a consequence of changing climate, the severity of malaria transmission and the duration of the transmission season in the northern regions of Pakistan are projected to increase in the future.

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Design and Fabrication of Electrochemical Amine Regeneration Cell for Carbon Dioxide Capture

Sana shaikh, Shumaila shaikh, Mehnaz umrani, Engr. Azizullah channa⁸

Abstract

Carbon dioxide is one of the primary greenhouse gases. With increasing in the population exponentially increasing the amount of transportation emissions, certain industrial processes and land use changes also emit carbon dioxide (CO₂). In several researches, there are several different alternatives which can be used for carbon capture. The carbon dioxide (CO₂) production is equally increasing, emissions of carbon dioxide from the combustion of fossil fuels like (coal, natural gas, and oil) by human activity for the energy. Electrochemical amine regeneration process is used to capture carbon dioxide. In this thesis study we have designed the electrochemical amine regeneration cell with an absorber to capture carbon dioxide. Later on, we performed the experimental procedures using completely different substrates and parametric conditions which can influence the carbon dioxide capture. It includes all the required operational parameters like (voltage, power supply, temperature, pH) are continuously being examined and monitored with the help of carbon capture capturing CO₂. We come across various results shown in graphs. Through the Electrochemical amine regeneration (EMAR) process greenhouse gases are reduced and reduce the global warming effect. This process reused the monoethanolamide solution continuously for the absorption of the Carbon Dioxide efficiently. It also implements SDGs in industries and is considered as a cost effective process for capture of carbon dioxide in developing countries like Pakistan.

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Freshwater Microalgae as Bio stimulant for Rice (*Oryza Sativa* L.) Crop Production: A Sustainable Green Agriculture

Sikandar Bakhat, Nayab Raza, Mehreen Raza⁹

Abstract

Agriculture is responsible for 27% of total emissions of carbon-di-oxide, nitrous oxide, methane and other chemicals in atmosphere for climate change. The excessive use of chemical fertilizers in land resulted into environmental pollution and affected the crop yield. These fertilizers have bad impact on soil health that further absorbed by the crops. For climate change, microalgae are the most efficient in the CO₂ bio-fixation system and the greatest producer of oxygen (50%) on the earth. Therefore, in this study, the bio-fertilizer is manufacture from native freshwater microalgae biomass. Microalgae is enriched with nitrogen (N) phosphorous (P), potassium (K), and other minerals necessary for plant and crop growth and optimum yield. A comparative study has been conducted on chemical fertilizers with Freshwater Microalgae fertilizer (sequesterate carbon from the atmosphere and convert them into a fruitful nutrient) to overcome this issue. A hectare of land was selected to perform this study; the land was divided into two portions each containing an equal area of 1.25 acres. After sapling, these rice plants are ploughed into the land finalized for comparative study. In comparison, dosage concentration was set at 1:1 (50kg Urea:50kg DAP= 100kg/dose/acre or 250kg/hectare/dose) for synthetic fertilizer while the Freshwater Microalgae base Biostimulant was set to be sprinkled on the rice plants by mixing up with water, (26ltr/dose/acre or 65ltrs/dose/hectare). Traditionally the farmers feed the dose (chemical fertilizer) to the land thrice per crop, while for a comparative study the same number of doses were followed. Samples of soil and plants were collected before and after feeding the fertilizer to the crop. This comparative research study reveals that Freshwater Microalgae based Biostimulant have the qualities to deal with soil fertility issues, high Carbon sequestration rate, and greater moisture to the soil, and high nutritious capabilities.

Keywords: Microalgae, Biostimulant, foliar Spray, Sustainable Agriculture

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Biodegradable sanitary napkin as best replacement of chemical and plastic pollution: A call for global action

Mehreen Raza, Nayab Raza, Safina Kamboh, Sikandar Bakhat ¹⁰

Abstract

In developing countries, menstrual hygiene management (MHM) is one of the serious and unavoidable challenges for women in general and aggravating climate change in particular in the 21st century. According to agenda 2030, the United Nation's sustainable development goals (SDGs), such as SDG#3 and #13, aimed to ensure good health and well-being and climate action, respectively. Plastic used in daily needs and menstruation is no exception. To manage this natural process a woman has to use some sanitary product which has plastic in anyway and that finally ends up in the trash and becomes a massive part of the solid waste. Plastic based hygiene product being completely leak proof brought ease in women life but also trouble for being non-biodegradable more than 1000 years. In Pakistan, 11% of solid waste is solely consist of these problematic sanitary napkins. However, in Pakistan, "79% of women in Pakistan manage their periods unhygienically and are not aware of menstrual hygiene management (MHM). In addition, around 1,50000 tons of sanitary napkins and dirty cloth waste are generated every year, composed of 90% plastic and not undergo biodegradation. Therefore, to overcome such problems my research is an innovative and eco-friendly solution is to make a biodegradable sanitary napkin made up of natural herbs and sustainable materials. In this study, a Sanitary napkin composed of three layers having different biodegradability duration with respect to time. The proposed biodegradable sanitary napkins consist of top hydrophilic biodegradable cotton and a bottom hydrophobic biodegradable layer; the absorbent core consists of banana pulp and cellulosic non-woven cotton. Nano colorant method, soil burial test to examine biodegradability test. There was no effect of the soil burial test on commercial sanitary napkins, whereas the proposed sanitary napkin was readily biodegraded up to 50% in just three months. Conclusively, biodegradable sanitary napkins are an excellent replacement for commercial plastic and chemical-based sanitary napkin. They are biodegradable, safe, and eco-friendly.

Keywords: Climate change, Biodegradable, Neem, Banana pulp

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Assessment of Water Saving, and Yield of Wheat Planted Onridges and Flat Bed under Soil Salinity

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Abstract

Under arid and changing climate patterns, water shortage leads to the salinization of soils due to the evaporation of groundwater. Water-saving technologies, including land preparation and planting methods, assume importance for water-saving and bringing additional areas under cultivation, which helps counter the salinization process. This study was conducted to determine the comparative value of ridge vs flatbed cultivation of different wheat varieties at the Malwah distributary of district Shaheed Benazirabad, Sindh, Pakistan. Wheat was cultivated with two farmers, one male (Farm 1) and one female (Farm 2), in the Rabi 2021 in the mid and tail areas of the distributary, as it faced a shortage of surface water at these reaches. In each case, improved variety (TD1) was compared with the farmers' variety, and additionally, Kiran was also tested on Farm 2. Soil texture was SiCl at both the farms, with EC of 0.28 (F1) and 0.31 (F2) dS/m. The data showed that TD1 grown at F1 on ridges yielded 37.6% higher than the same variety grown on a flatbed. Furthermore, ridge irrigation required 47.77 % less water than flat-bed irrigation. Due to the shortage of surface water at F2, the wheat was primarily irrigated by pumping groundwater. The yield of TD1 was 15% higher than the same variety grown on the flatbed, and the ridge irrigation method saved 38.4% water compared to flat-bed irrigation. The Kiran variety grown on ridges at F2 yielded 14.82% higher than the same variety grown on the flatbed, saving 33.7% irrigation water. The water Productivity (WP) obtained for ridges and flatbeds is 1.15 and 0.48 kg/m³ at F1 and F2, respectively. It is concluded that ridge cultivation of wheat saves water and yields more than flatbed cultivation.

Keywords

Surface water, Malwah Distributary, Wheat, Ridge and flatbed irrigation, Yield, Water saving, Water Productivity (WP).

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The Gauging of Aquifers Fluctuation and Groundwater Economy in Quetta Valley, Balochistan, Pakistan

Areeb Ul Haq¹⁴, Abdul Latif Qureshi¹, Muhammad Afzal Jamali¹⁵, Shahzad Hussain¹, Farhad Ali Memon¹

Abstract

Quetta is the fifth largest city of Pakistan and capital of Balochistan province with a population of nearly 3.0 million. It is an arid mountainous region with low mean annual precipitation of 150–200 mm between 1999 and 2020. The demand of water in Quetta Valley is increasing day by day due to surge in population. Groundwater is only the source for domestic, industrial and agriculture purpose. Due to increased burden on groundwater, it is depleting at an alarming rate of 1.5–5.0 m/year in certain parts of the city. The Quetta Valley comprises of two types of aquifers: the alluvial aquifer (unconfined) and the limestone aquifer (confined). The aquifers were depleted after two decades of heavy use from hundreds of illegal tube wells and agricultural wells. The objective of this study is to assess the fluctuation rate in both the aquifers through piezometer data from the observation wells present in valley. Furthermore, to calculate the extraction rate of groundwater in different pumping stations of Quetta valley and to investigate the socioeconomic impact of groundwater tankers in city through questionnaire survey. To achieve this goal, the data regarding groundwater levels, tube wells and pumping rates were collected. The data showed that the depth of alluvial aquifer is between 150ft to 300ft and the limestone aquifer extends from 350ft to 1200ft. The abstraction rate for the city has increased from 32.25 MGD to 57.76 MGD over 20 years. The water budget calculated showed that the average recharge per year in the study period was 37.04 MGD and the average abstraction from the aquifer was 84.20 MGD, so there was annual deficit of 47.11 MGD.

Keywords: Groundwater, Water Budgeting, Aquifers, Tube wells, Quetta Valley

1. Introduction

Groundwater is widely acknowledged to be an important source of drinking water when there is no rainfall (Naomi et al.2019). The source of drinking water for more than 30% of the world's population is groundwater aquifers, hence its contribution is crucial (Nasir Ali et al.2018). Since the groundwater reserves are greater than surface water, it also contributes in economic growth and provide a steady supply of water for household, agricultural, and industrial uses.

Groundwater development for industrial, agricultural, and household purposes has exploded during the past 50 years, with extraction rates of 750–800 km³/year (Shah et al.2000). Groundwater storage is drained, and the water table lowered when the abstraction rate is higher than the usual recharge. Maintaining a balance between recharge and abstraction is essential for the sustainable management of groundwater resources.

Pakistan is the third-largest consumer of groundwater for irrigation in the world (IAH, 2022). About 60 billion m³ gallons of groundwater have been extracted in Pakistan overall. 27% of the region can be effectively irrigated using surface water resources, while the other 73% is either directly or indirectly irrigated with groundwater. Currently, there are 1.2 million private tube wells operating throughout the

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nation, with Punjab accounting for 85% of them, Sindh for 6.4%, Khyber-Pakhtunkhwa for 3.8%, and Baluchistan for 4.8% (MDPI 2020).

Groundwater levels in Balochistan have been declining for decades as a result of decreased precipitation, rising temperatures, protracted droughts, and an increase in tube well construction. By 2015, there were more over 40,000 tube wells, up from around 5,000 in 1980 (PCRWR, 2018). As a result, groundwater levels have been dropping quickly, with some basins seeing a decline of more than 5 meters per year. (World Bank Group, 2019).

The Balochistan province's urbanized and inhabited metropolis, Quetta District, covers a total area of 603 km² and is located between 30° 0' and 30° 30' N and 66° 40' and 67° 15' E. (Khair et al. 2012). With a population of just under three million, the reliance on groundwater resources has led to water shortages throughout the hot summer and dry winter months. Quetta receives 28 million gallons of water each day, however there is a daily 17 million gallons' shortage in the city. The amount of water needed in Quetta per day by 2026 will reach 75 million gallons. In Quetta, the depth of the subterranean water has decreased to 2000 feet. It is estimated that water table in Quetta valley is declining at an average rate of 4-5 feet per year (Syed Fazal et al. 2019).

2. Study Area

The selected study area is the Quetta District, which is the metropolitan city serving as the capital of the Balochistan province in Pakistan. The Quetta Sub-basin covers a total area of 603 km³ and is located between the latitudes of 30°0' to 30°30' N and 66°40' to 67°15' E (Khair et al. 2012). The Quetta city has a population of more than 3.0 million and is thought to be the one most affected by the water resources available, will soon face a serious issue. With an average elevation of 1,680 meters (5,510 feet) above sea level, Quetta is the only significant city in Pakistan that is located at a high altitude.

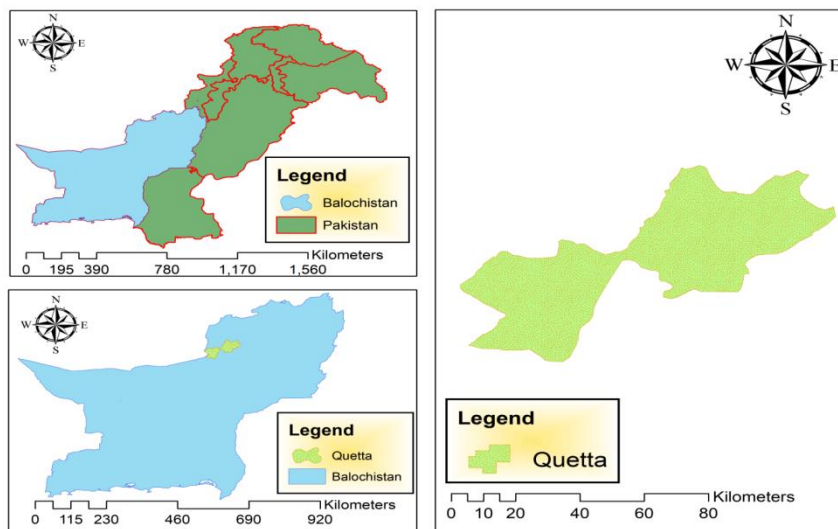


Fig. 1: Location Map of the Study Area

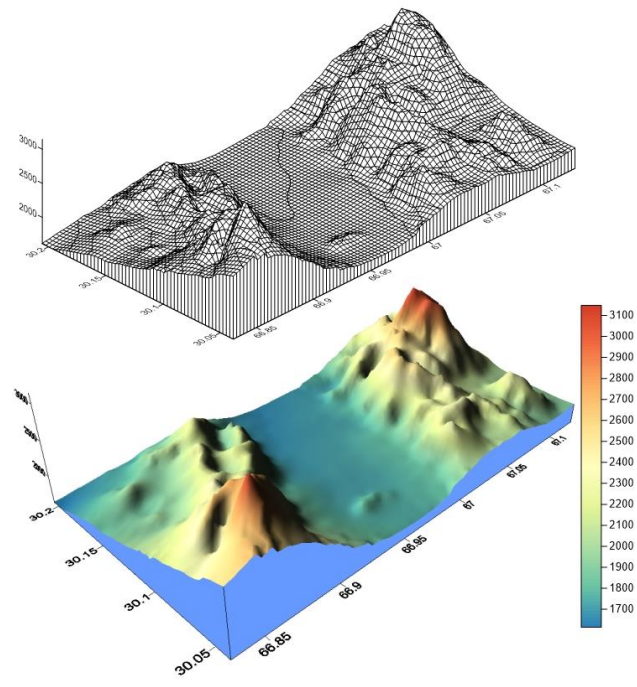


Fig. 2: Elevation Map of Quetta Valley

2.1 Climatology

The Quetta Valley experiences a semi-arid environment with large seasonal temperature variations. Winter and spring bring rain and snowfall that is mostly westward, but since the valley is not in the monsoon belt, summers are often dry. Summertime averages are between 24 and 26 °C, while autumn averages are between 12 and 18 °C, wintertime averages are between 4 and 5 °C, and springtime averages are between 15 and 20 °C. While September had the lowest average monthly rainfall (0.3 mm), January had the greatest average monthly precipitation (56.7 mm) (Durrani et al., 2018).

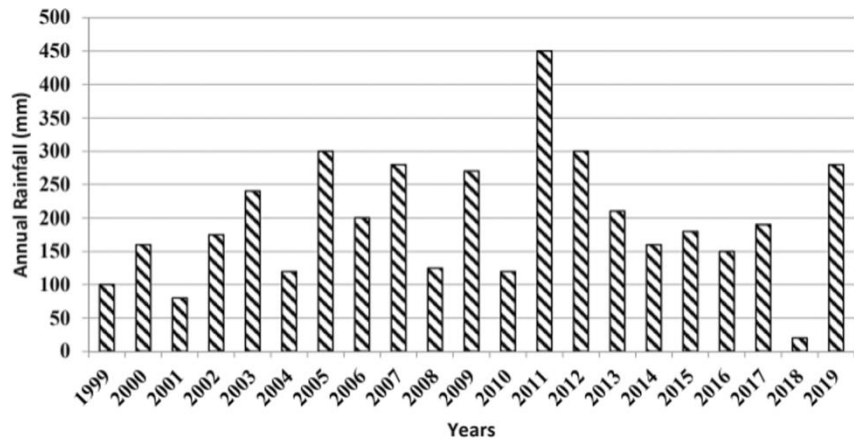


Fig. 3: Annual rainfall data of Quetta Valley for the past 20 years (Khan et al. 2021)

2.2. Geology

The Quetta Subbasin formed as a component of a significant anticline/syncline structure that runs about north to south. The study area's geologic features are a result of the Himalayan orogeny.

Quetta is about 1,650 m above mean sea level, and is bounded by the Murdar (height of 3134 m), Chiltan (peak height 3261 m), Zarghoon (peak height 3519 m) and Takatoo (peak height 3401 m) mountain ranges. The bowl shaped valley of Quetta is bordered by dry mountains comprising rocks of Triassic to Pliocene age (Umar M. et al. 2014).

The mountain ranges at the shoulders of the subbasin are Jurassic comprised of Shirinab and Chiltan Formations. The geology and structural characteristics of the subbasin have been impacted by the tectonically active Chaman Fault, which runs north to south (Imad Ali et al. 2022). Quetta Valley formed as a synclinal valley filled with Quaternary sediments beneath Middle to Lower Jurassic hard-rock formations. In several parts of the subbasin, the limestone, conglomerates, and sandstones are visible. The drainage border for the majority of the valley is formed by the Middle Jurassic Chiltan Limestone formation, which is exposed at the subbasin rims. The Paleocene Dungan limestone is visible along the Chiltan Range in the west, whereas the Chiltan Limestone encompasses the whole Murdar Range. The massive conglomerates of the Pleistocene are exposed all along Zarghoon Range in the north.

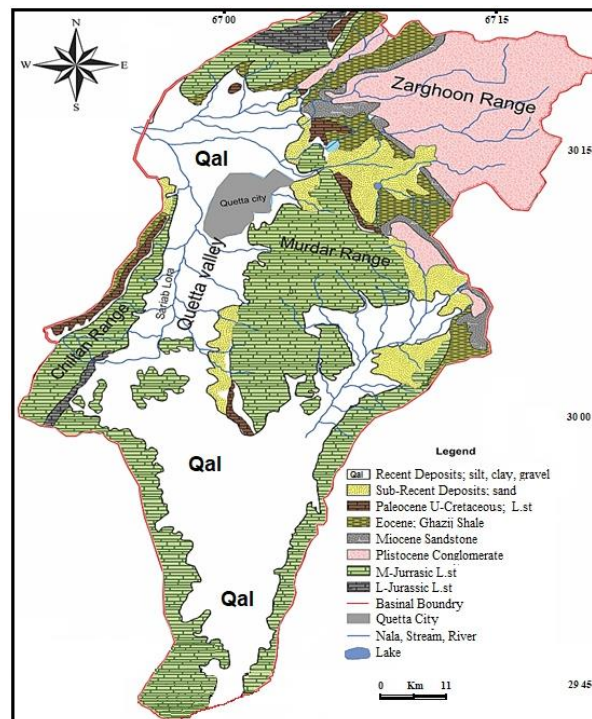


Fig. 4: Geological Map of Quetta Valley (Imad and Mubashir,2022).

		AGE	FORMATIONS	Thick- (m)	LITHOLOGIC	DESCRIPTION
MECOZOIC	QUATERNARY	HOLOCENE	Alluvium/ Alluvial	30-1500		Course stream channel material, sub-angular, sub-rounded pebbles include silt, sand, clay and gravel
		PLIOCENE PLESTOCENE	Urak Fm.	470-940		Thick bedded conglomerates, olive to maroon soft shale, interbedded brown green, sandstone, claystone & siltstone
	TERTIARY	MIOCENE	Shinmithai	120-300		Grey, brown to greenish fine-course sandstone, claystone, calcareous sandstone and conglomerates
		EOCENE	Gazij Fm.	590		Grey to greenish shale, abundant Foraminifera, interlayered claystone, limestone & conglomerate
		PALEOCENE	Dungun Fm.	300		Grey to brown limestone & shale
			Upper	Brewery Fm.	25-60	
		Goru Fm.		70		Thin bedded, grey limestone interlayered siltstone & shale
	Lower	Sember Fm.	135		Black silty shale interbedded argillaceous limestone & siltstone	
	JURASSIC	Middle	Chiltan Fm.	1800		Thick bedded micritic, finely crystalline, grey to black, brownish limestones. Exposed in most mountain ranges surrounding Quetta Valley
		Lower-Middle	Shirinab Fm.	1500		Grey to black, thin to medium bedded limestone interlayered with dark grey to black shale and sandstone layers at base

Fig. 5: Lithostratigraphic Column of Quetta Subbasin (Imad et al. 2022)

2.3. Hydrogeology

There are two aquifers beneath the Quetta valley. The unconfined alluvial aquifer, which is the top layer and makes up the valley floor, is composed of a combination of gravel, sand, and clay. It is between 150 ft and 300ft below the surface. The thickness of the alluvial aquifer increases gradually from the valley shoulders to the center and from the southern to the northern part of the valley (Aftab et al, 2022). The second aquifer, a restricted aquifer made of limestone formation, ranges in depth from 350 ft to 1,200 meters (Imran et al. 2021). Due to the active tectonism of the Chaman Fault System, hard-rock formations of limestone and conglomerates are heavily jointed and fractured with well-developed secondary porosity and permeability. Direct replenishment of the aquifers occurs along mountain slopes through exposed limestone formations from precipitation and surface runoff.

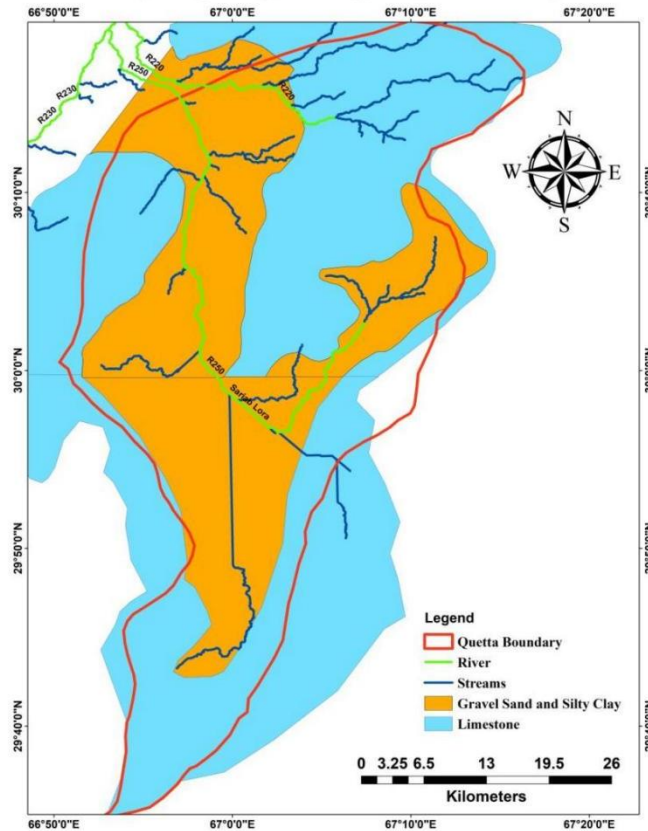


Fig. 6: Hydrogeological Map of Quetta Valley.

3. Methodology and data processing

The methods are based around the objectives which have been set.

Numerous works of worldwide, national, and regional literature were examined and analyzed in order to comprehend the overall idea of groundwater. The topographical, hydrogeological, geological, and groundwater modeling studies from various places locally and worldwide are among the consolidated resources that were carefully examined.

Research work will be done in two phases:

3.1. Groundwater Budgeting

The questionnaire survey has been done of pumping stations in the main city and both eastern and western bypasses in order to calculate the groundwater economy (budgeting) and then map the discharge zone. Water budgeting will be done by water budget equation.

The balance equation of the groundwater system is given below.

Inflow – Outflow = Rate of change in storage

The groundwater aquifer system's intake and outflow are described by the volumetric water budget. In the recharge component, precipitation and irrigation water losses will be regarded as aquifer inflows, whereas groundwater extraction by pumping and evapotranspiration will be regarded as aquifer system outflows.

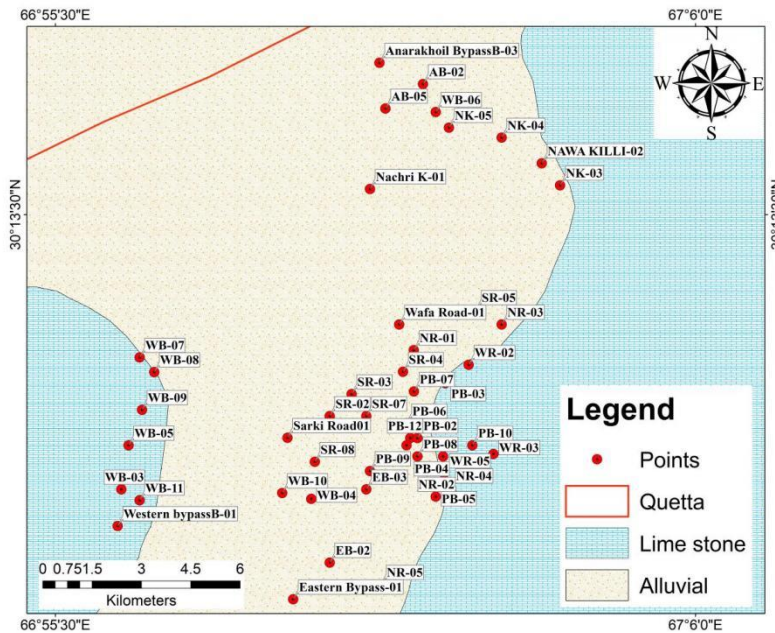


Fig. 7: Location map of pumping stations.

3.2. Fluctuation in Aquifers

The piezometer data have been used to evaluate aquifer fluctuation in order to measure liquid pressure in a system by measuring the height to which a column of liquid rises against gravity within the Quetta Valley. There are more than 50 monitoring boreholes in the area, out of which 09 boreholes were selected with a monitoring period that ranges from 1990 to 2022 for water-level record analysis. These long-term groundwater-level monitoring data were obtained from the Water and Sanitation Agency (WASA), Quetta. The groundwater-level data indicated that the frequency of water-level monitoring ranges from monthly to annually. To calculate the growing and declining trends, statistics have used on 09 boreholes with complete water-level data. After making a well hydrograph, water level fluctuations have been noticed over time, as well as dramatic rise and fall points.

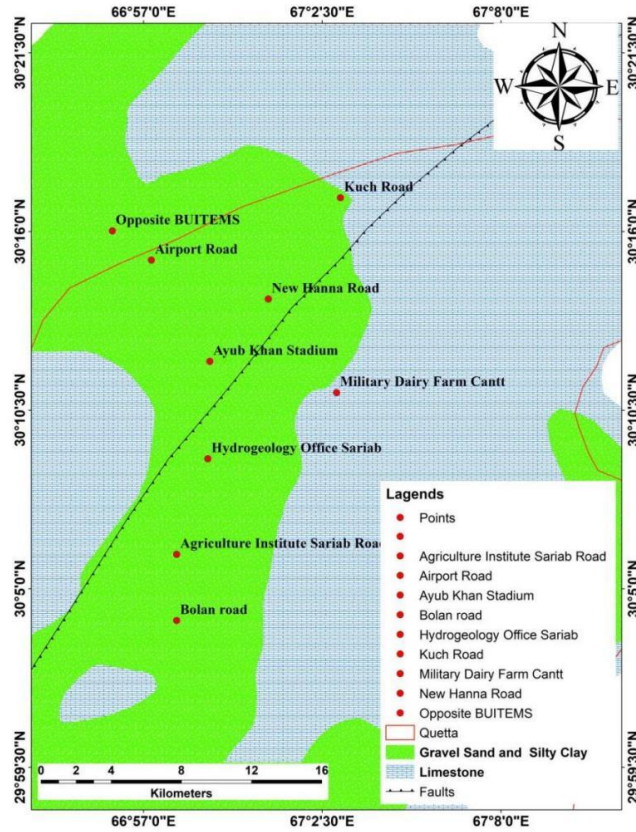


Fig. 8: Location Map of boreholes in Quetta Valley.

4. Results and Discussions

The pumping stations are showing the variability in the depth of bore. All pumping stations have bore depth greater than 600 ft as shown in Fig. 8.

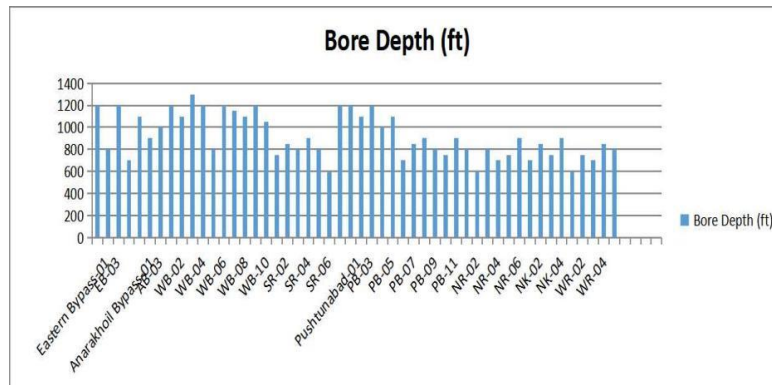


Fig. 9: Depth of bore of pumping stations

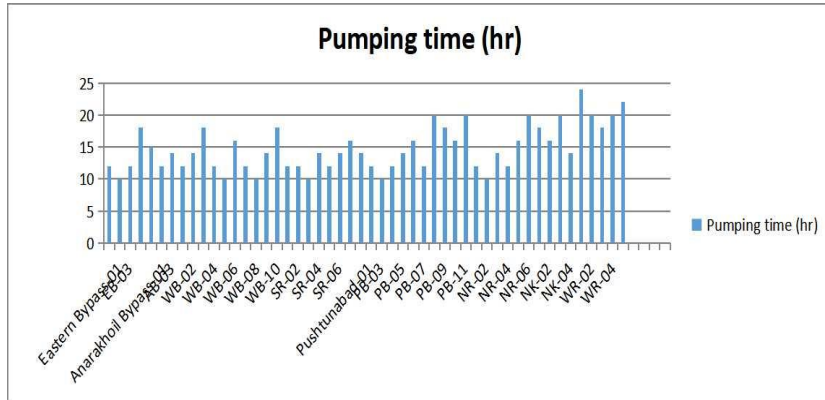


Fig. 10: Pumping time of the bore in each day

The Fig. 10 is showing the discharge off the number of tankers from pumping stations in each day. So, the total number of tankers from the given results becomes 1915 in each day.

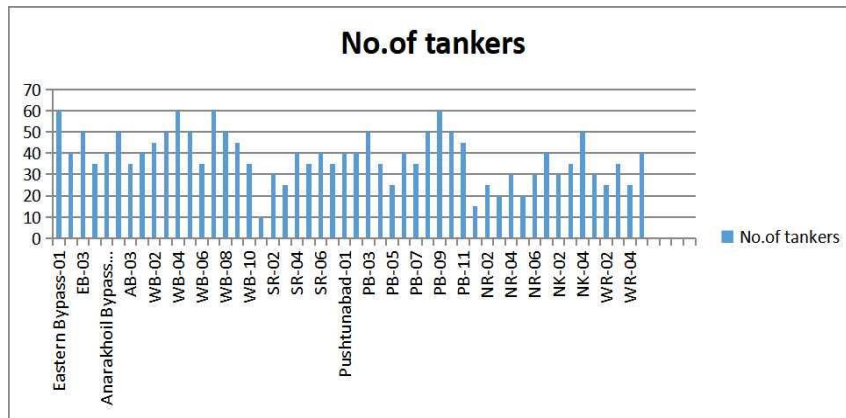


Fig. 11: No. of tankers of each day

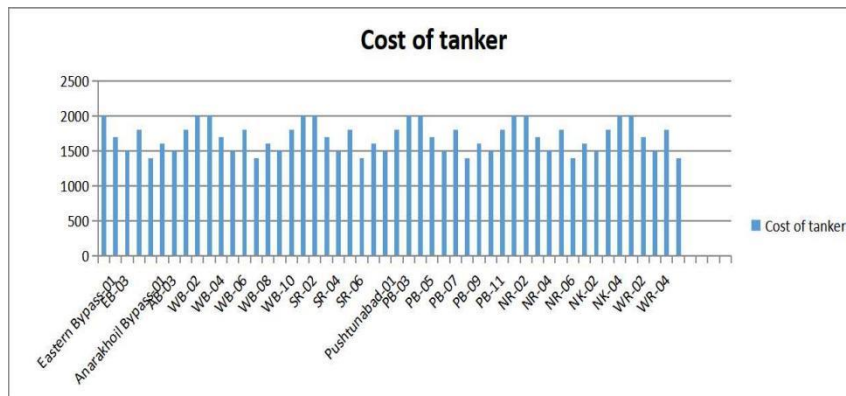


Fig. 12: Cost of each tanker in different pumping stations

The water budget calculated showed that the average recharge per year in the study period was 37.04 MGD and the average abstraction from the aquifer was 76.6 MGD. So, the Annual deficit of 39.56 MGD.

5. Conclusion

There are two different types of aquifers in the Quetta Valley: an alluvial aquifer (unconfined) and a limestone aquifer (confined). After being heavily utilized for 20 years by hundreds of unauthorized tube wells and agricultural wells, the aquifers were exhausted. The depth of alluvial aquifer is between 150ft to 300ft and the limestone aquifer extends from 350ft to 1200ft. Limestone aquifers are of great interest as a drinking water resource. The static water level in the Quetta Sub-basin has decreased between 1987 and 2020, both in the limestone and an alluvial aquifer. The static water level in the Limestone aquifer was found to be falling by 1.0 to 2.5 m/year on average. The declination in the alluvial aquifer was calculated to be 1.5 to 5.0 m/year. Majority household has to order water tankers to meet its requirements. Residents pay Rs2,000 for a tanker of water which is sufficient enough for five days. According to the water budget calculations, there was an average annual recharge of 37.04 MGD throughout the research period, and an average annual drain from the aquifer of 76.6 MGD. Therefore, there is a 39.56 MGD annual deficit.

6. Recommendations

- There is no alternative method to prolong the period of time until the water table reaches a point where it cannot be economically used.
- Eliminating losses from the water delivery system is necessary.
- It is necessary to establish a charging system that both promotes and compels individuals to consume as little water as feasible.
- Locating the best locations for minor dams, low-lying depressions, and artificial lakes is also advocated in order to control rainfall and regularly replenish the aquifers for later usage.
- To identify suitable locations for artificial recharge well construction that will allow rainwater to infiltrate into groundwater.
- Farmers should practice pumping at irregular intervals, for instance every two to three hours, in order to teach them how to do it.
- To start a campaign to educate Quetta Valley inhabitants about the usage of groundwater and the aquifer's depletion.

Exploration of Groundwater Resources for Future Settlement of Population in Northern Areas of Quetta Valley through Vertical Electrical Sounding

Qayyum Habib Abdul Latif Qureshi¹⁶

Abstract

Groundwater is the most abundant source of water that humans can consume, so it is usually preferred as a supply of drinking water. Baluchistan is experiencing a groundwater crisis due to frequent drought spells, overexploitation of groundwater, urban expansion, poor understanding of hydrogeological conditions. In this study, northern areas of Quetta valley have been explored using electric resistivity method for deeper understanding of hydro geophysical conditions. The field, data have been processed and layer modelling through IPI2win software, which displays the layers of each survey point in the form of 1D sections and pseudo-section which shows the apparent resistivity thickness and depth. 18 VES were conducted at Quetta North from Pishin bypass to Boston area in five different profile lines at the depth of 500 m. The distance between each VES point is 2km. In profile 01 freshwater aquifers were encountered in silty clay and silty sand lithology at average depth of 250 m. in profile 2,3 and 4 aquifer bearing limestone lithology were encountered, in profile 5 aquifers were explored in silty sand lithology at the shallow depth of 100 m. Due to presence of silt in aquifer these are also low pressure and low potential aquifer considered. it is recommended that find other sources of water in area only groundwater will not bear the burden of shifted population. The aquifers should be recharge by installing artificial wells and concerned departments must formulate strategies for monitoring groundwater in the area.

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

1. INTRODUCTION:

Through taking measurements on the ground surface, a groundwater resistivity survey can identify the distribution of subsurface resistance. Pakistan's Indus Basin Irrigation System (IBIS) irrigates millions of hectares of agricultural land while simultaneously serving as a vast reserve of groundwater for the country's water and food security. Only 20% According to the World Health Organization, the populace has access to clean drinking water. In geological formations, groundwater is created by hydrostatic pressure within the pores and fissures of rocks. Due to intense population in Quetta city and its surrounding groundwater depleting rapidly, so it's high time to planning for future generation of people of Baluchistan to explore a suitable place to shift population from main city to in northern parts of city where potential subsurface aquifers will have encountered. (Lawrence, 2012). In this investigation, the resistivity data utilized to investigate the groundwater, have been collected using the SAS4000 Terameter, which is available at USPCASW, MUET Jamshoro.

2. STUDY AREA:

Quetta is the capital of Balochistan. The total catchment area of the valley is 1757 km², of which 792 km² are alluvial. The Quetta valley is located in the Quetta Pishin sub basin, which is also known as the southern basin of the North East Pishin Lora Bain (NEPL)(Alam and Ahmed, 2014). Quetta valley to the north and Dasht plain to the south are separated by the hills of Mian Ghundi and Landi (Kakar et

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al, 2020). Over the past 30 years, Quetta Valley's population has grown significantly. Groundwater is the primary source of water for domestic and agricultural needs.

3.

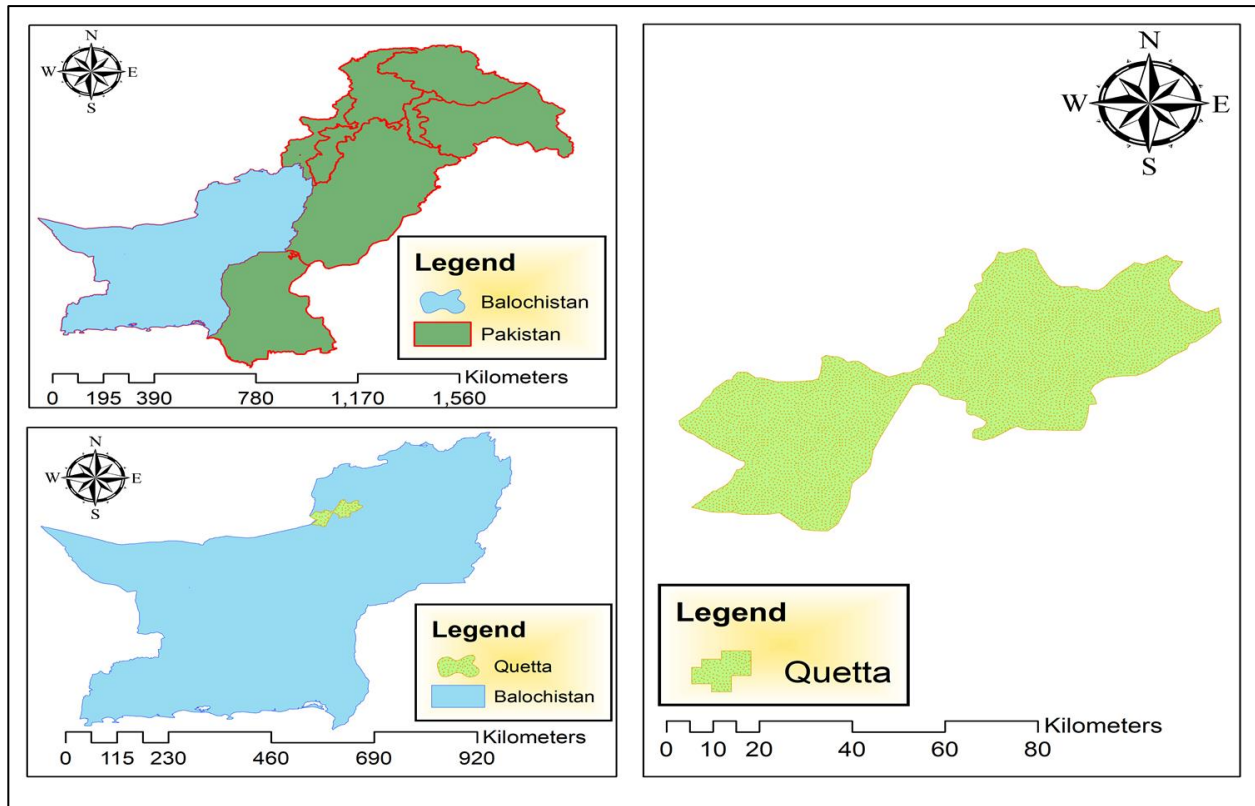


Fig 1 Location map of the area.

4. GEOLOGICAL SETTING:

The formations exposed in the area are sedimentary in origin and range in age from Triassic to Recent. These rocks are folded and faulted and axes are oriented in NE-SW directions (Kazmi et al., 2005). Shirinab Formation limestone with subordinate shale, Chiltan Limestone exposed in north-eastern ranges of Takatu ranges. Bostan Formation exposed in the north and north-western part of the area, forming low hills semi-consolidated mainly composed of clay and silts with subordinate gravel. Mainly gravelly deposit mostly silts and clays but at places gravel layers in the valley floor (Qureshi, A.L et al, 2022).

5. MATERIAL AND METHOD:

Generally, two potential electrodes are used to monitor the voltage difference that arises from injecting current into the ground using two current electrodes (C1 and C2) (PI and P2) (Soomro, et, al 2019). Schlumberger soundings frequently have better resolution, greater probing depth, and speedier field deployment than alternative configurations (Khan et al. 2013). The 06 VES curves' geo-electrical sections are made and stacked along five section profiles based on the resistivity contrast of diverse lithologies. The VES-defined layers' thickness, depth, and individual resistivity are isolated by the IPI2win software.

Table no 01: The Relationship between the quality of the water and the geological formation

Resistivity Zone	Resistivity(Ohm-m)	Relationship between the quality of the water and the geological formation
Low	<10	This zone has the ability to support saline to less saline water carrying due to the presence of fine materials like clay/shale and uncommon sand.
Medium	10-30	The presence of intermediate sand with some clay is indicated by this zone. Additionally, it might be a sign of alternating sand and clay/shale bedding. If the formation is below the water table, it can produce groundwater.
High	30-100	This area is thought to be dominated by coarser material, such as sand, and high-quality groundwater.
Very High	>100	If bed rock is found below the water table, the extremely high resistivity can indicate the presence of an unsaturated zone above it.

6. RESULTS AND DESCUSSION:

The probe there are Six (06) on which SAS4000 Terrameter data were gathered at Quetta North from Pishin Bypass to Boston area in five different profile lines. The distance between each VES point is 2km.

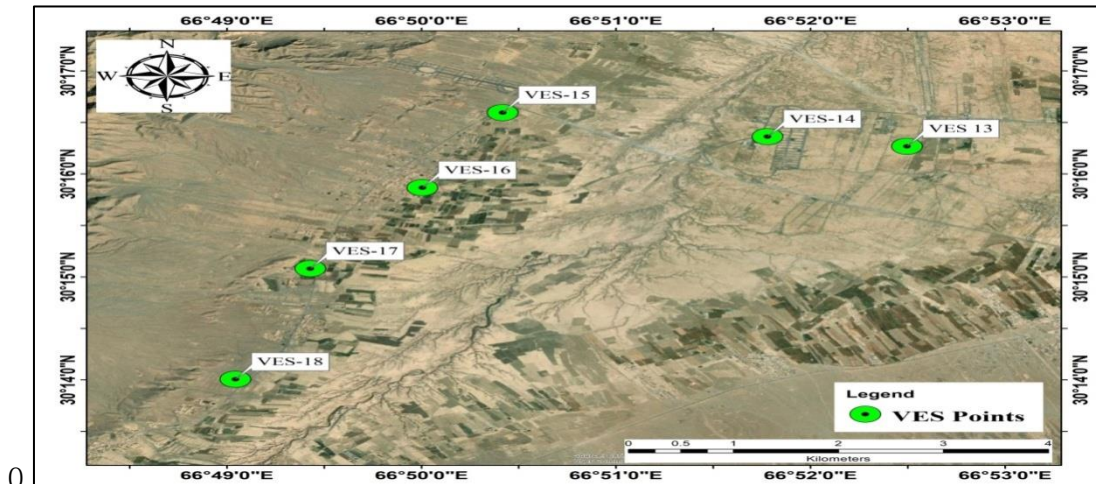


Fig 2 VES Location map

VES PROFILE-01 was carried out at the left side of Pishin bypass which reveals in profile 01, a total of four lithological layers were indicated. Major lithology was interpreted clay, silty sand, silty clay,

limestone. In profile 01, aquifers are found in VES 13,14,15,16. Mostly aquifers are present in limestone at 250 m in depth and 200 m in thickness on average.

PROFILE-01

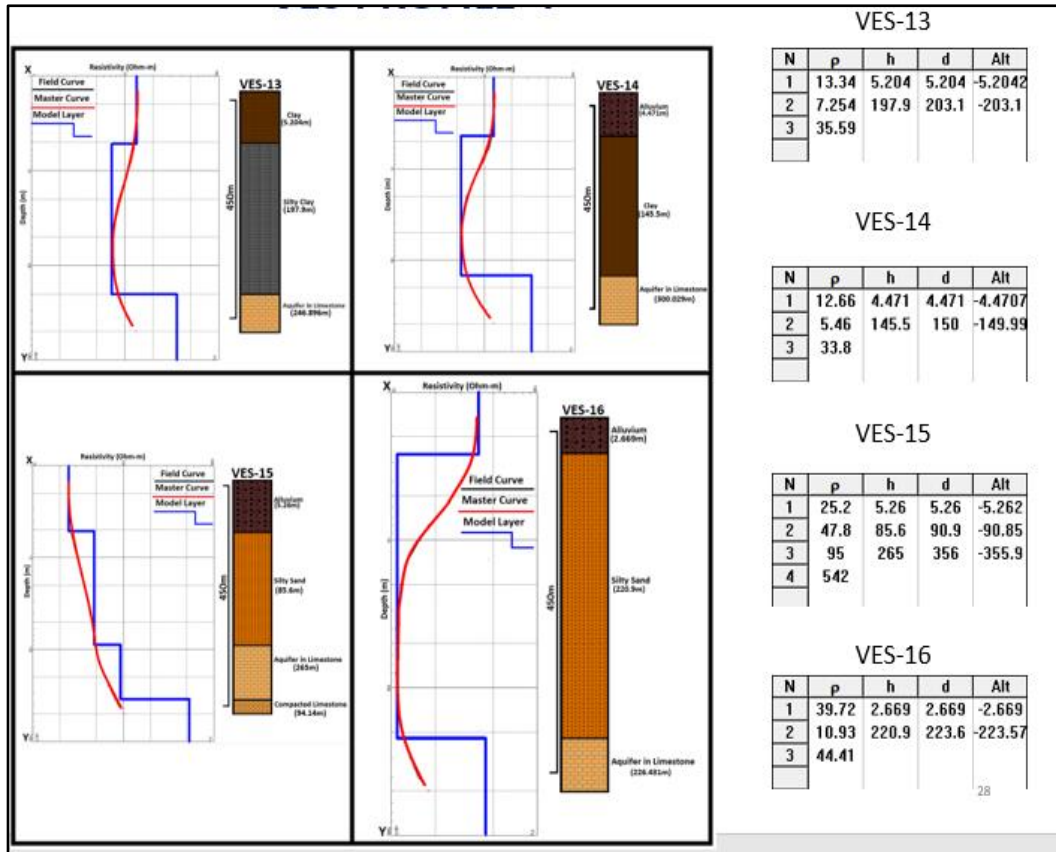
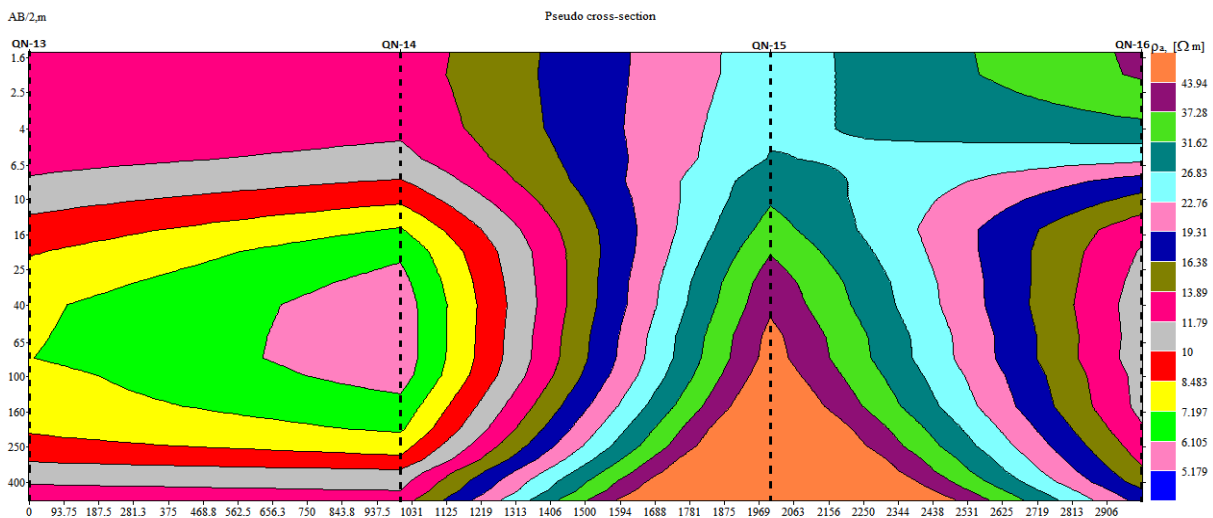


Fig 3 Geo-Electrical Sections of Profile-01 of the Study Area



VES PROFILE-02 was carried out at the left side of Pishin bypass which in profile 1 aquifer bearing limestone lithology were encountered at average depth of 250m reveals Major lithology was interpreted alluvium, silty sand. In profile 02, aquifers were explored in VES 17, 18. Mostly aquifers are present in silt sand at 100 m in depth and 350 m in thickness on average.

PROFILE-02

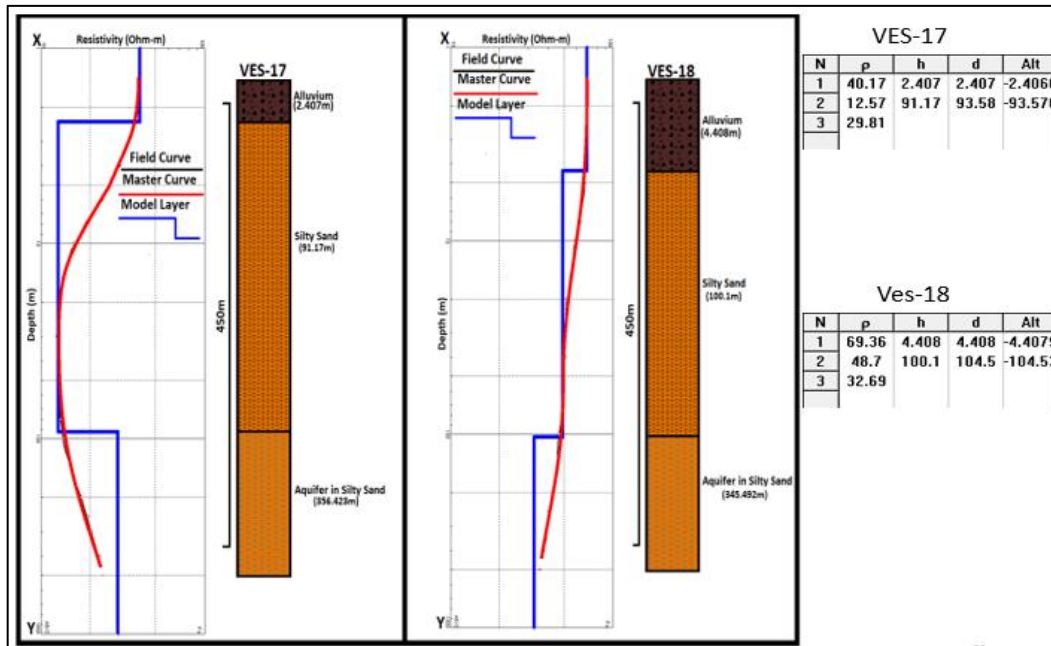


Fig 5 Geo-electrical sections of Profile-02 of the Study Area

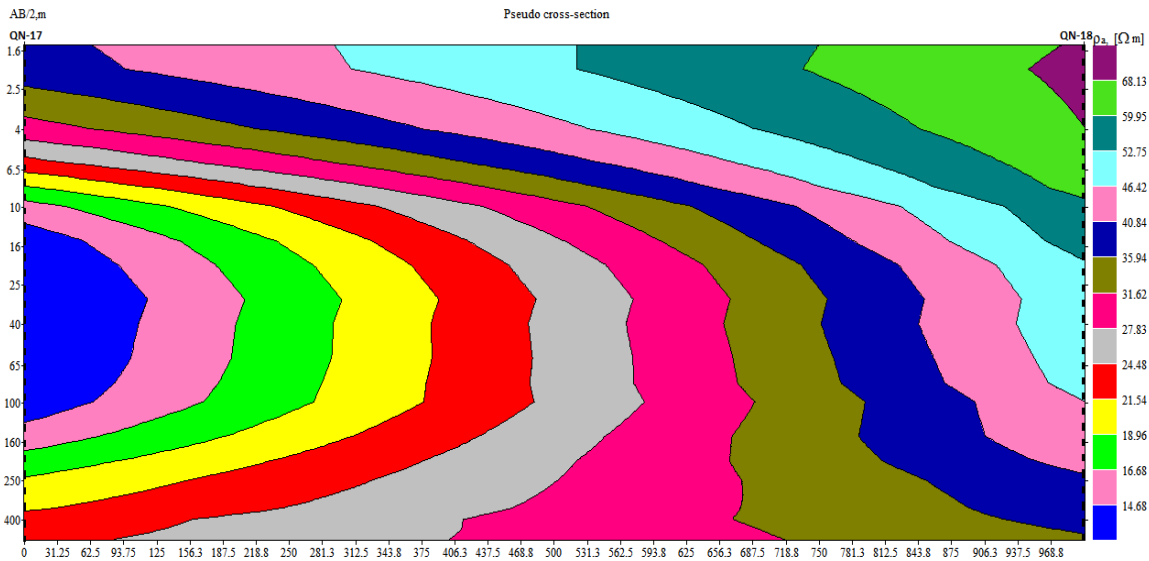


Fig 6 Pseudo cross sections of Profile-02 of the Study Area

7. CONCLUSION:

- In profile 1 aquifer bearing limestone lithology were encountered at average depth of 250m.
- As a result of lithology's clay and silt content, these aquifers have low potential, low pressure, and low hydraulic conductivity.
- Moving towards North near Kuchlak area in profile 01 and 02 aquifer bearing limestone lithology was encountered.
- In profile 02 aquifers were explored in silty sand lithology at the shallow depth of 100 m.
- Due to presence of silt in aquifer these are also low pressure and low potential aquifer considered.

RECOMMENDATIONS:

- It is recommended that on the basis of hydrogeological condition of area,
- Shifted population will face water shortage problem in future due to non-planned development.
- It is recommended that find other sources of water in area only groundwater will not bear the burden of shifted population.
- The responsible departments must develop plans for observing the local groundwater.

8. ACKNOWLEDGEMENT:

The authors are thankful to the Higher Education Commission, Islamabad for providing full financial support under Local Challenges Fund Project No. 20-LCF-63. The authors are thankful to the Team of Balochistan University of Information Technology, Engineering and Management Sciences and Mehran University of Engineering & Technology, Jamshoro, Pakistan, for the collection of literature data and the writing of this Paper.

Hydro-Diplomacy and the Prospects of Environmental Peace building between Pakistan and India

Bilal Aslam¹⁷,

Abstract

Pakistan and India share a history of animosity on many issues including transboundary water sharing. India, being an upper riparian in the Indus basin has a comparative advantage over Pakistan and in recent times has started building a series of dams on the western rivers which Pakistan considers a violation of Indus Water Treaty (IWT) signed in 1960 that limits India's consumptive rights of the western rivers. It has resulted into increased tensions between Pakistan and India but the mutual vulnerabilities like the water scarcity have yet again brought in a possibility of the 'compulsive-cooperation' around shared water resources. This growing water scarcity is creating 'interdependency' that necessitates cooperation for mutually beneficial solutions for both Pakistan and India. The Indus Water Treaty (IWT) in this regard ensures sustained cooperation on transboundary water sharing and sets the parameters for the hydro-diplomacy between Pakistan and India which also has the spillover effect for settlement of outstanding disputes between the two neighboring states of South Asia, thus paving the way for the regional peace and integration. The paper reviews the literature on hydro-diplomacy and incorporates the discourse analysis to analyze the efficacy of the principles of cooperation laid down in Indus Water Treaty (IWT) and evaluates the possibilities of the future of environmental peace building between Pakistan and India.

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Microalgal-based hydrochar for the removal of fluoride from groundwater

Zulaikha Saeed, Muhammad Rizwan¹⁸

Abstract

Excessive fluoride concentration in groundwater is a major problem. In different areas of Pakistan, the fluoride concentration in groundwater is above permissible limits of WHO. In this study, adsorption process was used for the removal of fluoride from groundwater. The hydrochar of microalgae (*Chlorella vulgaris*) was prepared with the help of hydrothermal carbonization (HTC) process. The hydrothermal carbonization process conducted at 199 °C for 24 hours. The characterization of hydrochar done by scanning electron microscope (SEM) for the examination of morphology of hydrochar, Fourier transformed infrared radiation (FTIR) for the analysis of presence of functional groups on hydro char, energy dispersive X-ray (EDX) was used for analysis of elements in hydrochar, and Brunauer-Emmett-Teller (BET) surface area analyzer was used for the analysis of surface area of hydrochar. The FTIR results showed the presence of different functional groups its surface of hydrochar. The EDX results showed the high carbon content in hydrochar. The fluoride removal analysis from whatever was done with the help of a batch adsorption study. Fluoride analysis done by UV/V is spectrophotometer with SPANDS method. The results showed that the increase an initial concentration of fluoride (1.4-5mg/L) the removal efficiency also increased at pH6 and 200 rpm. Maximum fluoride removal was 96% at pH6. Initial concentration was 1.4 mg/L, 0.05g/L adsorbent dose at 60 minutes. This adsorption followed the langmuir isotherm resulting monolayer homogeneous adsorption on the surface of hydrochar. Pseudo second order was supported for kinetics that confirmed the chemisorption.

Keywords: *Chlorella vulgaris*, fluoride, Hydrochar, hydrothermal carbonization

Introduction

Fluoride is the 13th most abundant element present in the earth's crust. It is well-known that the existence of fluoride in drinking water is good for public health. However, exposure to a higher concentration of fluoride (above 1.5-2mg/L) can cause dental and skeletal fluorosis [1, 2,3]. According to an estimate, 200 million people around the world are forced to drink fluoride contaminated drinking water.

Fluoride is not biodegradable. It accumulates in the soil and can leach into ground water. In areas where ground water is the only source of drinking water fluoride contamination can cause different health problems [4-6]. Fluoride is a highly electronegative element and can easily bind to highly positive elements like calcium which can result in dental and skeletal fluorosis[7, 8].

For the prevention of adverse effects of fluoride, several studies tried to remove the fluoride from drinking water. The most common methods used for defluoridation include chemical-precipitation, adsorption ion-exchange, reverse osmosis (RO), and electro-dialysis [9-12]. These methods are expensive, produce by products, and fouling. There is a need to find a simple, cost-effective, and easy to operate method for fluoridation. Adsorption is a desirable technique for the defluoridation of drinking water [13, 14]. So, adsorption can be used for defluoridation [13, 15].

Hydrochar:

Hydrochar is prepared by hydrothermal carbonization. In this process biomass including algae, agricultural waste, wood, and vegetables are heated at 200-300 °C in a wet environment. For the hydrothermal carbonization process, the temperature must not be more than 300° C because then the liquefaction

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process stated. There are two phases of hydrochar, the liquid and the solid phase (slurry). It requires more heat to dry for defluoridation.

The hydrochar is mostly used for defluoridation of fluoride-contaminated water used for drinking purposes. The hydrochar removes fluoride from drinking water with an adsorption process in which the functional groups attached to the surface of the hydrochar attract the fluoride from water due to electrostatic forces. The properties of hydrochar can be checked through its characterization. The characterization of hydrochar shows its efficacy of fluoride removal, from water, adsorption capacity, chemical and elemental composition as well as the functional groups present on its surface area. The porosity of hydrochar has a great impact on the defluoridation process that is also determined by the morphology characterization of hydrochar.

Several technologies are designed for defluorination of water. The commonly used technologies for defluorination include coagulation [16], ion exchange [17], membrane filtration [18], chemical precipitation [19]. However, these technologies have several disadvantages like in the coagulation process some by-products are also produced which can cause health problems i.e. memory loss [20]. In the same way, some technologies are highly efficient but are expensive and require more technical skills. These technologies may include electro-dialysis, and membrane filtration (nano-filtration, reverse osmosis) [21].

Adsorption is considered a cost-effective method for the removal of contaminants from drinking water, particularly the inorganic contaminants [22]. The adsorption process can be defined as the adsorbate adhesion on the surface of the adsorbent that might be chemically or physically bounded. Hydrochar can be used as an adsorbent [23]. Different characteristics of hydrochar make it an ideal adsorbent for the defluorination of water like its porosity, surface area, high adsorption capacity and functional groups on its surface [24].

Hydrochar can be produced by using different biomass [25] like a vegetable waste [26] olive stone [27], Bamboo [15], Teff straw [28], Saw dust [29]. Previous studies had shown that a variety of biomass can be used as an adsorbent for defluorination.

Yihunu et al., 2019 investigated the water defluorination through biomass-derived activated hydrochar prepared by the carbonization process. The fluoride adsorption was 88.7 mg/g. The

mechanism behind adsorption was that electrostatic forces attract the fluoride. According to their findings activated hydrochar was an effective adsorbent for defluorination of water [30].

Yihunu et al., 2019

found that the novel activated hydrochar derived from Teff (*Eragrostis tef*) straw, can remove up to 88.7 mg/g fluoride from water. They also used Teff straw biochar for fluoride removal and found the removal capacity of biochar was up to 212 mg/g. They found that at 2 pH 1200

rpm and 120 minutes maximum fluoride absorption was achieved. Mukherjee et al., 2018 removed

fluoride from water by using biochar and hydrochar prepared from *Aegle marmelos*

(bael shell/wood apple) and *Parthenium hysterophorus*. They found that the biochar prepared by the wood had 89% removal efficiency at 10 mg/L concentration where as in the presence of *Parthenium hysterophorus* fluoride removal was 78%.

In this study defluoridation of drinking-water was done by using microalgal-based hydrochar. This method eliminated the fluoride from water through adsorption.

MATERIALS AND METHODS

Sample collection

The groundwater samples were collected in polyethylene bottles from two different provinces of Pakistan i.e., Sindh and Balochistan. The areas are Quetta Balochistan and Tharparker in Sindh.

Fluoride determination in drinking water

The water having a concentration of 50 mg/L of fluoride was prepared by NaF. The sample was diluted to prepare different concentrations of fluoride. Different fluoride concentrations including 1, 4, 2, 10, 20, 30, 40, and 50 mg/L were used for the analysis of removal of fluoride from groundwater. A constant concentration of hydrochar was added into the contaminated water. The sample was run on the shaker for 60 minutes. After that, with the help of syringe filters, the sample was filtered. For the determination of contamination of fluoride in the water, SPADNS method was used. The analysis was done by UV-spectrophotometer.

HYDROCHAR PREPARATION

Microalgae *Chlorella Vulgaris* spp. was collected from the laboratory of USPCAS-W. It was washed with deionized (D.I) water to remove all muds from it and then was air-dried. The hydrochar thermal carbonization (HTC) was performed in a Teflon-lined stainless steel reactor. For this, another 5 hours and was weighted. Finally, hydrochar was put into a desiccator.

BATCH STUDY

The batch study was conducted to check the adsorbent and the effective hydrochar dosage. For this purpose, different doses of hydrochar were used to find out the optimal dosage for the initial concentration of fluoride in water. A 200 mL flask with a known concentration of hydrochar with 50 mL fluoride-contaminated water was placed on an electric shaker for 2 hours (fixed period) at room temperature. Then the flask was removed, and the solution was filtered. The same batch was repeated 3 times to take the average value for consumption. Then the concentration of fluoride was measured using the SPADNS method.

Initial fluoride concentration-effect:

The fluoride concentration effect on removal percentage was calculated by changing the concentration of fluoride and keeping the rest of the variables constant like adsorbent dosages, agitation speed, and contact time.

pH effect on defluorination process

The effect of pH on defluorination was checked by adjusting the pH of the solution. The pH range for the adsorption study was selected between 2 to 12.

Results

Characterization

Scanning electron microscope (SEM)

The micrograph of the hydrochar was captured by SEM. SEM was used to determine the surface by an image generation through a fixed electron ray. The hydrochar determined at different functions of 0.61 μm , 0.276 μm & 0.100 μm . Figure 1 showed the micrograph of hydrochar before treatment of fluoride while figure 2 showed the monograph of hydrochar after treatment of fluoride. The micrograph of the hydrochar after treatment had defined and filled pores with fluoride. The pore size of the hydrochar was 0.51 and 0.100 micrometer respectively.

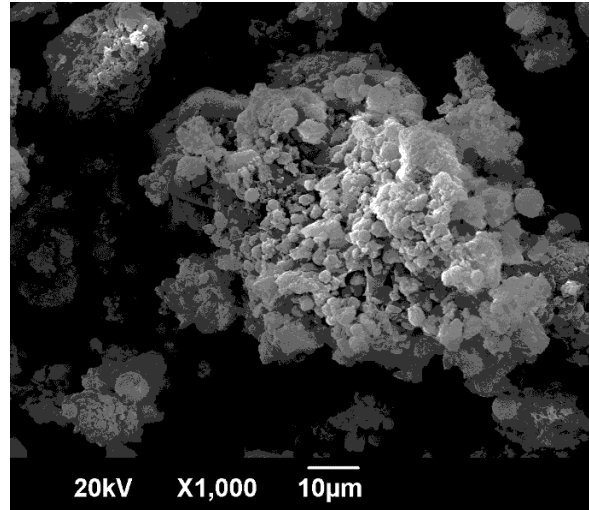


Figure1: Hydrochar before treatment

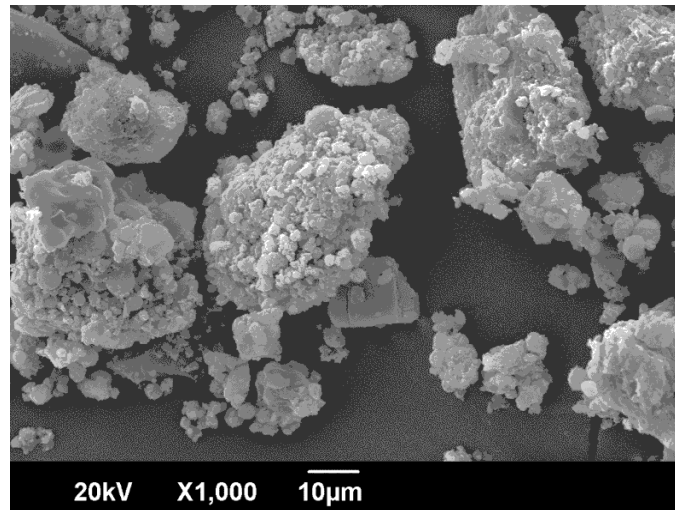


Figure2: Hydrochar after treatment

3.2.3. Effect of Fluoride Concentration

Hydrochar was used for the removal of different concentrations of fluoride. The results indicated that the maximum removal obtained at 50mg/L. The removal percentage of the fluoride was 96% at 50mg/L at 60 minutes (figure 3).

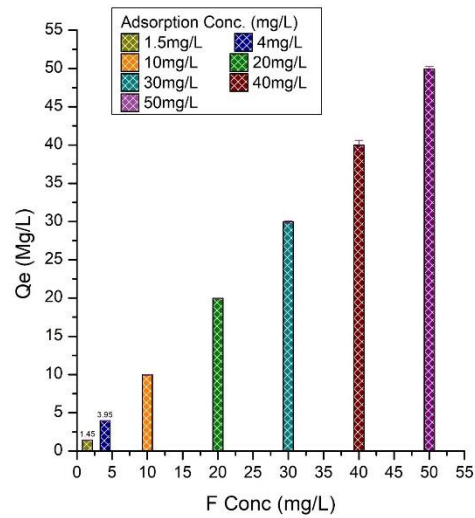


Figure3: Effect of fluoride concentration.

Effect of pH

For the determination of pH effect, the pH varied while the rest of the variables including time and concentration of adsorbent and adsorbate were kept constant. The result indicated that the maximum removal was at 6-8 pH. Figure 4 shows the effect of pH on fluoride removal.

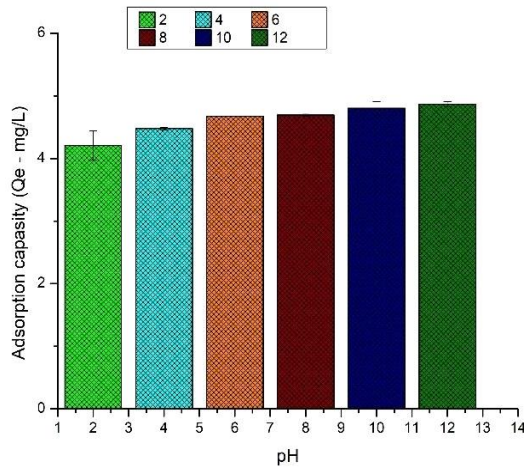


Figure4: Effect of pH on fluoride removal

Conclusion

In this study, a hydrochar was prepared by microalgae. The characterization and batch study of the defluorination of ground water were done. The structure and pore size of hydrochar indicated that it has a capacity to adsorb fluoride on its surface. The batch study resulted that the maximum removal of fluoride from water was done at pH 6-8, at 60 minutes and hydrochar concentration of 5mg/L.

Analysis of thunderstorm activity over Pakistan in recent years

Rehan Ahmed¹⁹

Abstract

Thunderstorm activity happened over Pakistan during the period 1996-2015, is investigated in this study. Observed data of monthly thunderstorm days recorded at 40 well-dispersed meteorological stations of Pakistan Meteorological Department (PMD) are analyzed. Seasonal and annual climatology, annual cycle, and trends of thunderstorm days based on the mentioned period across the study area are presented. Those stations which constitute core region of thunderstorm frequency are identified. It is detected that the region contains mountainous areas located mostly in upper half of the country. Pre-monsoon (AMJ) and monsoon (JAS) are most vulnerable seasons for development of thunderstorms. It is also observed that most of the stations exhibit increasing trends during winter (DJFM) and decreasing trends during Pre-monsoon, monsoon, and post-monsoon (ON) seasons.

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Synthesis of Room Temperature Ionic Liquids Based on imidazolium cation and Their Potential Application as Extractants of Sulfur-Compounds from Coal

Sofia Laraib, Uzaira Rafique²⁰, and Aliya Fazal

^a,

Abstract

This research is aimed to synthesize halogen free room temperature ionic liquids (RTILs) as agents for the extraction of sulfur compounds from coal. RTILs are 1-methyl dimethyl imidazolium sulfate [Mim⁺] [MeSO₄⁻], 2-ethyl dimethyl imidazolium sulfate [Eim⁺] [MeSO₄⁻], 1-methyl imidazolium perchlorate [Mim⁺] [HClO₄⁻] and 2-ethyl imidazolium perchlorate [Eim⁺] [HClO₄⁻]. These RTILs are synthesized by one pot greener route and characterized using Fourier Transform Infrared Spectroscopy (FTIR), Nuclear Magnetic Resonance Spectroscopy - Proton (H¹ NMR), and Dynamic Scattering Calorimetry (DSC) for detailed insight into structural and functional characteristics of RTILs. The synthesized RTILs were employed as extractive agents for the removal of organic and inorganic sulfur compounds from coal. Coal, which is an extensively used fossil fuel for the energy generation from thermal power plants, is emitting noxious pollutants. Emitted SO_x and NO_x have detrimental effects on living and non-living environment. Considering these facts this research aims to design desulfurization system to study the effect of extractive, oxidative and catalytic extraction. Hydrogen peroxide (H₂O₂) as oxidants and synthesized metal oxide nanoparticles were used as a catalyst. Oxides of zinc, nickel, zirconium, iron, titanium were synthesized by biogenic and co-precipitation methods. Various operating parameters i.e. Extraction time, RTILs to coal and oxidant ratio were investigated. It is evident from X-Ray Photoelectron Spectroscopy (XPS) results that the extraction efficiency of sulfur compounds was mainly dependent on the dosage of H₂O₂, RTIL, and the catalyst. Moreover, the highest desulfurization efficiency i.e. 60% was obtained at 30°C with optimized ratio of RTIL: Coal: H₂O₂ without significantly affecting the calorific values of coal. Furthermore, the experimental results are indorsed by Higher Performance Liquid Chromatography (HPLC) and Gas Chromatography-Mass Spectrometry (GCMS) for studying the separation and fragmentation patterns of sulfur compounds. The synthesized materials were found very efficient for remediation of organic as well as inorganic sulfur content of coal as validated through XPS results in this research.

Subject Category: Environmental Chemistry

Presentation Modes: Oral Presentation

Presence: Physical Presence

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Water Crises and Adaptation Governance: A Case of Agriculture Sector from Pakistan

Muhammad Mumtaz²¹

Abstract

The study contributes to develop a framework to understand the water governance by looking at the province of Punjab, Pakistan. The country is facing severe water crises and it may run dry by 2025. According to the International Monetary Fund, Pakistan is the third most water-stressed country in the world. Pakistan has the world's fourth highest rate of water use. Agriculture is the major source of economy in the country. Pakistan uses 93% of its freshwater resources on agriculture. This suggests that no country's economy is more water-intensive than Pakistan's.

Pakistan is an agricultural country and majority of population is dependent on agriculture sector. This sector contributes 24 percent of Gross Domestic Product (GDP) and accounts for almost half of employed labour force and is the largest source of foreign exchange earnings. However, agriculture sector is under stress due to population growth, increased demands for food, ever-growing competition for water and land, climate change, and less-participatory water resources governance. It is imperative to introduce improved water management in agriculture and adaptation of agricultural systems to enhance water use performance and water productivity, particularly to face water scarcity. This study is conducted to understand the water governance in the province of Punjab, Pakistan.

Punjab is the most populous and second largest province of Pakistan. The province accounts for 53 % of the total agricultural GDP in the country. The implementation of climate change, agriculture and water related policies are the responsibility of provincial government. The subnational/provincial governments play vital role to tackle the impacts of climate change, water crises, and food security. This study focuses to explore the prominent initiatives towards water governance in Punjab, Pakistan. It also identifies the key challenges in the way of effective water governance. More succinctly, the study contributes to establish a framework to tackle the risk of water scarcity based on preparedness rather than crisis approach.

This paper investigates the key initiatives to address the challenges of water crises and ensure sustainability in agriculture sector in the province of Punjab. Secondly, the paper identifies key challenges and evaluates the adaptation strategies to cope with water scarcity, including technology, use of strategic groundwater, and management. Finally, the paper proposes a framework for managing the risk of water scarcity based on preparedness rather than a crisis approach. The importance of diverse strategies to handle the forthcoming challenges associated with water resources management are emphasized, but the potential benefits depend on the appropriate multi-institutional and multi-stakeholder coordination to water resources management in a changing climate.

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A Smart Floating Waste Collector for Sustainability of Aquatic Biodiversity

Taha Hussain, Syed Mohammad Husnain Hashmi, Muhammad Azeem, Ramiz, Muhammad Usman Farid, Ch. Arslan, Abdul Nasir²², Abdul Shabbir²³

Abstract

Water is considered as one of the most precious resources in the earth's environment. Contamination of water bodies particularly due to solid wastes has become a potential risk to the whole ecosystem. Because of conventional dumping of solid wastes, the water bodies are being filled by several objects like plastic bottles, glass, tin cans, nails, metals and other non-biodegradable fraction of solid wastes which are generated from different anthropogenic like water-based transportation, entertainment, fishing etc. Considering such solid waste materials as food, the marine and aquatic animals (fish, sea birds, turtles etc.) try to cut and swallow these materials. This results in severe injuries, wounds, blockage of digestion system of the aquatic animals which ultimately results in death of very precious and innocent aquatic species. Moreover, the decay of dead and injured aquatic animals results in addition of extremely toxic bio pollutants to the water streams which become the part of food web. Hence, it is direly needed to protect the water bodies from the wastes particularly solid wastes which harm the aquatic lives. To cope with this problem, a small scale Smart Floating Waste Collector is under development phase in this research work being carried out at the Department of Structures and Environmental Engineering, University of Agriculture, Faisalabad for the removal of such harmful waste from the water bodies. The design of waste collector is based on the principle of floating ship/boat equipped with an automatic waste collection mechanism. There is an opening to the machine like a mouth in which waste goes in, being the reason, this is called as "Waste Eater". The machine gets its power from a rechargeable battery. A remotely operated "Control Unit" is provided for the handling and control of the machine in the water. The current research work will come up with a smart and optimized design of the waste collector for the sustainability of aquatic biodiversity.

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Rainwater Harvesting Potential Sites at Margalla Hills National Park

Dr. Bushra Khalid²⁴

Abstract

Life without water is not possible. Adoption of modern lifestyle and increase in population is leading to a water scarce world. The demand of world population cannot be met, which is resulting in increased groundwater abstraction. The world is facing water crisis and Pakistan is no exception. Urban areas of Pakistan are affected badly where extraction is higher while the construction of pavements has disturbed groundwater infiltration. The Federal Capital of Pakistan, Islamabad, is located in Pothohar region of the country and faces severe water shortages, particularly during summers. Extensive ground drilling by public and private users lowers groundwater table. Satellite imagery of LANDSAT 7 ETM+ and ASTER DEM 30m resolution were used to construct the site suitability map for groundwater recharge of Margalla Hills National Park. Factors considered included land cover, drainage density, elevation and slope. Suitable weightages were assigned to these factors according to their influence on infiltration in the study area. Since streams originating from Margalla hills are the main source of groundwater recharge for the areas lying at foothills and also are a source of surface water for the residents of capital city, as all the streams ultimately drain into Rawal Lake. The water recharge at Margalla Hills will help in raising the water-table level of the surrounding areas through increasing stream water flow, and the resultant increased runoff could be utilized effectively through harnessing the runoff by installing water harvesting structures at areas which are worst hit by climate change. Groundwater recharge potential at Margalla Hills National Park may prove to be effective in dealing with water crisis in Islamabad as it will raise groundwater table of the adjacent areas.

Keywords: Water scarcity, Groundwater recharge, Margalla hills, Islamabad, Urban sectors

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Chlorine Disinfection for Removal of Biofilms in Drinking Water Distribution Systems

Authors: Sanam Bhatti, Rasool Bux Mahar²⁵

Abstract

The presence of microbes in drinking water distribution systems (DWDS) have always been a major issue. Microorganisms in DWDS can form a biofilm, enabling them to survive the challenging conditions in a DWDS. This research was designed to investigate the potential of chlorine disinfectant at different dosages to remove the biofilms attached on the surface of different pipe materials. Four biofilm annular reactor (BARs) setups were designed and operated to find the impacts of chlorination on the biofilms. The total operation time of each reactor setup was three months, comprising of acclimatization for two months, during which no chlorine was added, and the biofilm was allowed to reach steady-state conditions. In the third month, chlorine was injected at constant concentrations in each reactor setup as: 0.5 mg/L, 1 mg/L, 1.5 mg/L and 2 mg/L, respectively. Acrylonitrile Butadiene Styrene (ABS), High-density polyethylene (HDPE), Polycarbonate (PC), Polypropylene (PP), and Polyvinyl Chloride (PVC) pipe materials as slides were mounted in each reactor setup. Heterotrophic plate count (HPC), and *Pseudomonas Spp* counts (log. CFUs/cm²) was calculated through the plate count method and by culturing them in serial dilutions on specified media. The HPC and *Pseudomonas Spp* showed zero colony counts on 2 mg/L disinfection dose. The result indicated that slide material had significant impact on biofilm growth; PVC and PC were the most suitable pipe materials for DWDS.

Keywords: Biofilm annular reactor (BARs), drinking water, chlorine disinfection, different pipe materials, Heterotrophic plate count (HPC), and *Pseudomonas spp*.

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Spatial Crop Management Using Remotely Sensed Soil Moisture Contents Estimation under Semi-Arid Condition

Kinza Farooq²⁶; Muhammad Naveed Tahir²⁷; Zahidan Farooq²⁸, Parishey Bilal

Abstract

Soil moisture and land surface temperature are key variables that controls the variation of arid zone crop production. It is not easy to get a huge estimation of soil moisture by applying ground based network. Now days numerous new techniques have introduced, and triangle method is one of them vegetation index and land surface temperature to calculate topographical soil wetness status (Carlson *et al.*, 1994) and it was presented by Prince. In this study two new indices (Fractional Vegetation Cover (F_r) and Vegetation Condition Index (VCI) are presented, and these are based on one of triangle method index NDVI. NDVI is not strongly linked with the soil moisture variations because when inadequacy of water appear the leaves are quiet green while LST is still vulnerable to soil wetness states. The primary design of triangle technique is that (LST) is strongly related with topsoil moisture and the flora that covers the soil. This research was organized in district Rawalpindi during the winter seasons of 2016. Collected soil samples from 63 different sites by using GPS position then the yield from an area of $1m^2$ was harvested from same sites (63 sites) then the yield converted in kg/hectare. For remote sensing evaluation the data of Landsat8 was downloaded from USGS. The coefficient of determination (R^2) between VCI with soil moisture contents and grain yield showed $R^2=0.849$ and 0.948 respectively.

Fractional vegetation cover showed better outcomes as compared to NDVI. The coefficient of determination (R^2) between NDVI with soil moisture and grain yield showed $R^2=0.849$ and 0.92 . In case of fractional vegetation cover with soil moisture contents and grain yield showed $R^2=0.888$ and 0.93 .

Keywords: soil moisture estimation, vegetation indices, spatial crop management, remote sensing and Landsat8

INTRODUCTION

Soil moisture plays an important role in cultivated area management. There are two main constituents of soil moisture: Moisture that is present in upper soil at 10cm called top soil moisture and the other component is rhizome section condensation is held in 200 cm upper area of soil. (*Esfahani et. al. (2015)*).

In 21st century society is facing a complex and sustainable matter of food security. Food supply of world is affected by climate changes, unsustainable use of land and increase in the population growth rate will bring remarkable stresses on world supply of food demand. Different methods have been used for example with the help of best irrigation practices proper fertilizer applications and development of new varieties as a result we can get higher yield. The average universal climatic condition becomes predicted with certain intensity of accuracy with the advancement in techniques to assess the actual effect on moisten-soil-plant life. This network is critical as significance for global financial system and food productivity (*Mishra et. al. (2013)*).

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Now days numerous new techniques have been introduced and triangle method is one of them to estimate soil moisture contents. In this method vegetation index and land surface temperature to calculate topographical soil moisture status (Carlson *et al.*, 1994).

The (TM) Triangle Method is classify as a thermal infrared method (Wang and Qu 2009) and uses the two parameter LST Land Surface Temperature and NDVI Normalized Difference Vegetation Index for measuring the soil moisture through remote sensing along with satellite imagery. The Triangle technique was firstly presented by Price (1990) and later elaborated upon by many other peoples (Carlson *et al.* 1994; Carlson *et al.* 1995; Gillies and Carlson 1995; Lambin and Ehrlich (1996); Gillies *et. al.* (1997); Owen *et. al.* (1998); Jiang and Islam (1999), (2001), (2003); Chauhan *et. al.* (2003). This method has been proved by numerous investigations (Gillies *et. al.* (1997); Carlson (2007); Wang *et al.* (2007); Mekonnen (2009) presenting adequate performance (with R² range between 0.6 -1.0) to estimate soil moisture.

Soil moisture interaction with many factors of environment needs strong measurements. The development in technology and accurate apparatus not only determines moisture of soil but also explain its variability at defined regions. The technique of interpolation formed between ordinary points does not produce results because technique does not explore top soil roughness, vegetation states, contour and different necessary conditions. This work is planned for accurate estimation of soil moisture contents and its relationship with different indices on Landsat8 data.

The important objectives of this work were

To calculate and mapped soil wetness at spatial resolution by using remotely sensed data and ground based measurements.

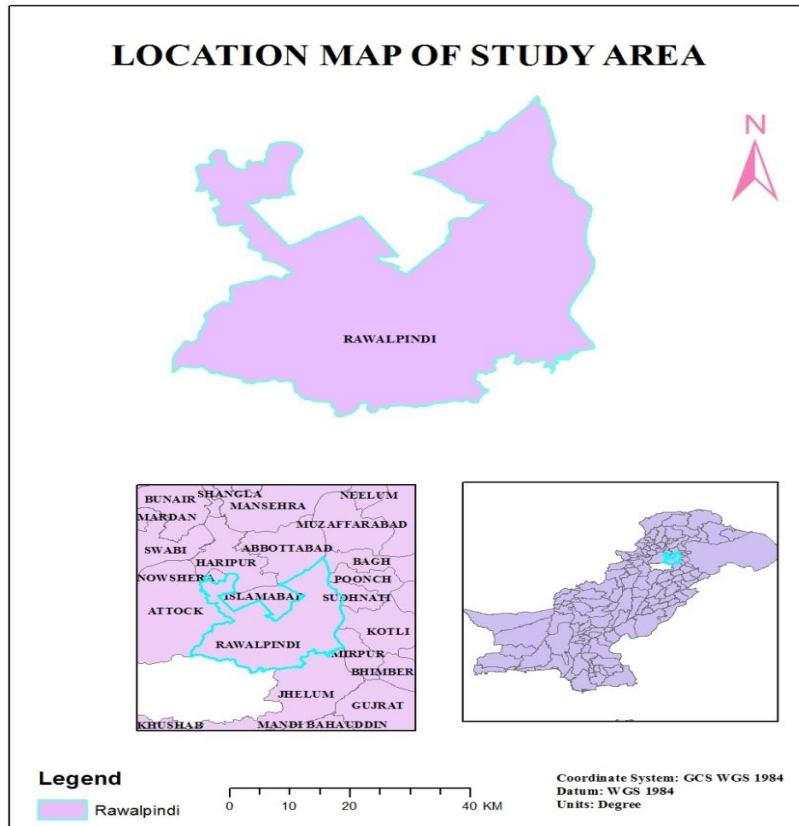
To analyze the temporal and spatial changes of soil dampness during study period.

To develop relationship between soil moisture and yield for spatially managed crops.

MATERIALS AND METHODS

STUDY AREA

The suggested study was implemented in district Rawalpindi. District Rawalpindi lies from 33° to 40° North and 44° to 30° East with an elevation of 508 m. Total area of Rawalpindi is 259 km² (100 sq mi).

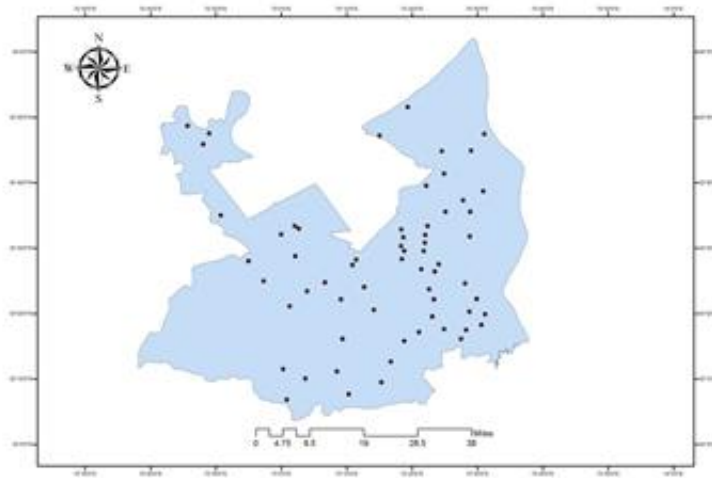


Rawalpindi district has population is approximately 1,991,656 as stated by 2006 census. Rawalpindi has humid sub-tropical climate with prolong and hot summer, moderate and wet winters and a short monsoon.

SOIL MOISTURE

We collected soil samples from 63 different sites by using GPS position the point of site selection mapped drawn by using Arc Map 10.2.2.

RAWALPINDI



Soil Moisture points in Rawalpindi district

We collected the soil with the help of auger up to 30cm depth and weighted with the help of weighting balance at the collected sites. After weighing the soil sample dried in oven at 105°C for 24 hours then cool it at room temperature. Then the soil moisture contents were calculated by using following formula

Moisture Content= $\frac{\text{Wet weight}-\text{Dry weight}}{\text{Dry weight}} \times 100$

GRAIN YIELD ESTIMATION

The yield from an area of 1m² was harvested from the same sites (63 sites) where we collected the soil samples for moisture. Then the yield converted in kg/hectare.

DIGITAL IMAGE ANALYSIS

There are many different tools and software available for the analysis of satellite images. After assembling images from available source then the images were passed through various analysis processes. In images analysis process GIS and ERDAS are used.

Preparatory Activities

Land Surface Temperature (LST) of Landsat8

Use thermal bands for LST and in Landsat8 there are two thermal bands. Band 10 which corresponding to the thermal and band 11 also with different wavelengths. The first thing we went to USGS (<http://earthexplorer.usgs.gov/>) to learn how to convert my Digital numbers to radiance which is the very first to go. Most of the operations can be done on raster calculator.

Convert Digital Numbers into Radiance

This conversion can be done by following formula:

$$L_{\lambda} = M_L Q_{cal} + A_L$$

Where

L_{λ} = Spectral radiance

M_L = Band specific multiplicative rescaling factor obtained from metadata file

Q_{cal} = Digital numbers

A_L = Band specific additive rescaling factor obtained from metadata.

Find radiance from this formula of both thermal bands of landsat8 data.

Convert Spectral Radiance to Satellite Brightness Temperature

Temperature can be estimated by using following formula:

$$T = \frac{K_2}{\ln\left(\frac{K_1}{L_{\lambda}} + 1\right)}$$

Mean

After calculating satellite brightness temperature for both band 10 and band 11 so we used average of these two bands and calculate mean by using Cell Statistics Tool on Arc Map 10.2.2

Proportion of Vegetation

This can be estimated by following formula:

$$P_v = (\text{NDVI} - \text{NDVI}_{\min} / \text{NDVI}_{\max} - \text{NDVI}_{\min})^2$$

Deriving LSE

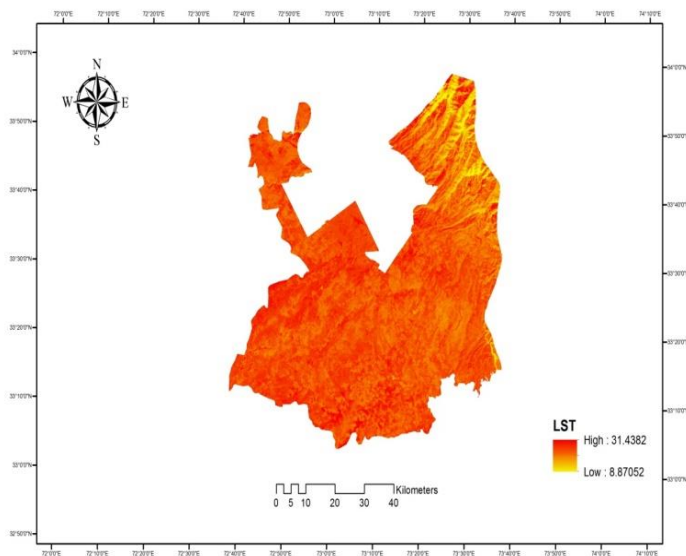
This can be done by following equation:

$$e = 0.004P_v + 0.986$$

Derive LST

This can be estimated by following equation:

$$\text{BT} / (1 + w * (\text{BT} / P) * \ln(e))$$

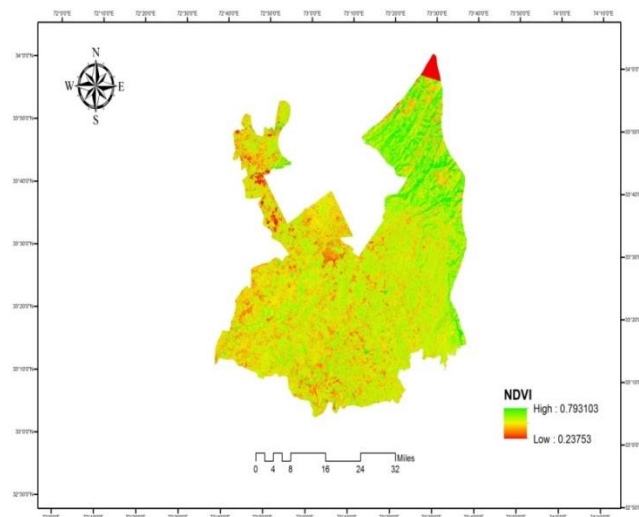


LST map of district Rawalpindi during month of February (2016)

Normalized Difference Vegetation Index (NDVI)

NDVI can be calculated from the following equation:

$$NDVI = \frac{NIR - R}{NIR + R}$$

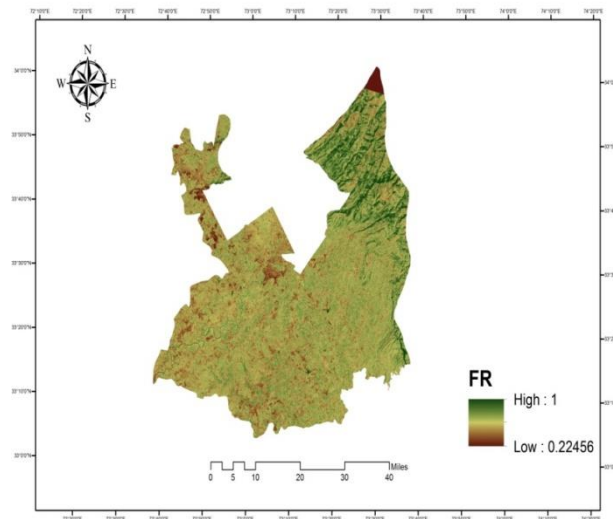


NDVI map of district Rawalpindi during month of February (2016)

Fractional Vegetation Cover (F_r)

We can determine F_r by using following formula

$$F_r = \frac{NDVI - NDVI_{min}}{NDVI_{max} - NDVI_{min}}$$

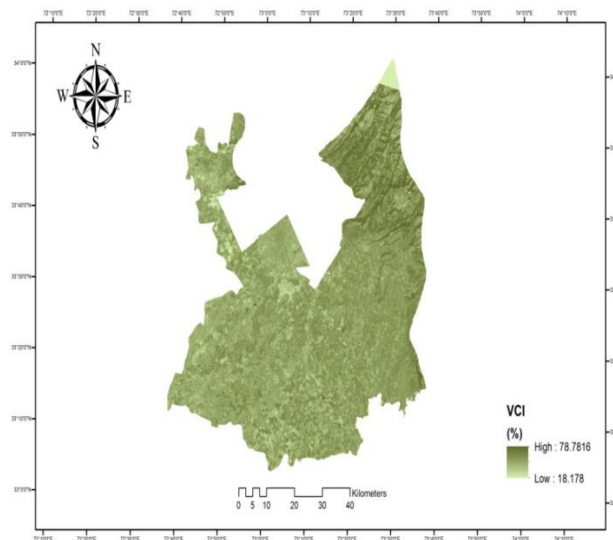


Fractional vegetation cover map of district Rawalpindi during month of February (2016)

Determine Vegetation Cover Index (VCI)

Vegetation Condition Index can be determined by following formula

$$VCI = 100 * \frac{P_{NDVI} - P_{NDVI_{min}}}{P_{NDVI_{max}} - P_{NDVI_{min}}}$$



VCI map of district Rawalpindi during month of February (2016)

STATISTICAL ANALYSIS

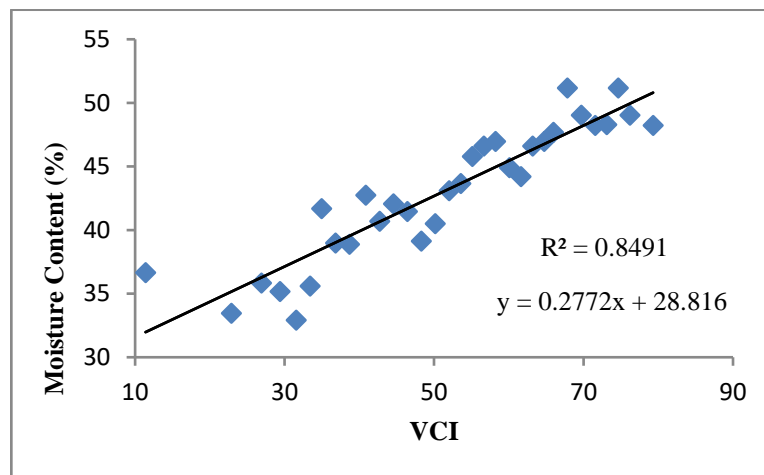
Statistical analysis was executed to evaluate and built a relationship between land surface soil moisture and satellite derived parameters by using SPSS and Excel and different tables and graphs were obtained. Regression model was used to get a relationship between ground-based soil moisture contents and satellite derived indices. To finalize the results, develop correlation between ground-based soil moisture data and satellite derived indices. Map of various types parameters developed on Arc Map 10.2.2 representing soil moisture contents.

RESULTS AND DISCUSSIONS

RELATIONSHIP BETWEEN SOIL MOISTURE AND VEGETATION INDICES

3.1 VCI and Soil Moisture

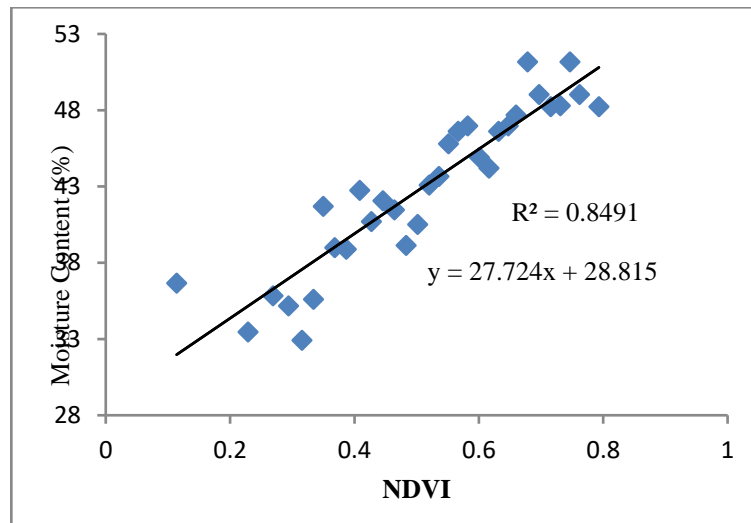
A vegetation index is a standard that explains the health of green vegetation cover, crop greenness and relative density for each pixel or picture element in a satellite data. Normalized Difference Vegetation Index is a numerical gauge that utilizes both near infra-red and visible portion of electromagnetic spectrum and it is adopted to study satellite remote sensing estimations and evaluations whether the object being observed carries live greenish vegetation or not. The vegetation cover index of district Rawalpindi in the month of February 2016 ranged from 18.1 to 78.7 while the value of normalized difference vegetation index was 0.11 to 0.79. The linear relationship between vegetation cover index and soil moisture contents was drawn.



From ANOVA table, a strong correlation developed between VCI and soil moisture data with $R=0.79$ with a strong linear coefficient of determination value of $R^2=0.849$ as shown in figure: 06 presented approximately 85% precision in results and significant correlation between VCI and soil moisture contents with $F=51.8$ value.

3.2. NDVI and Soil Moisture

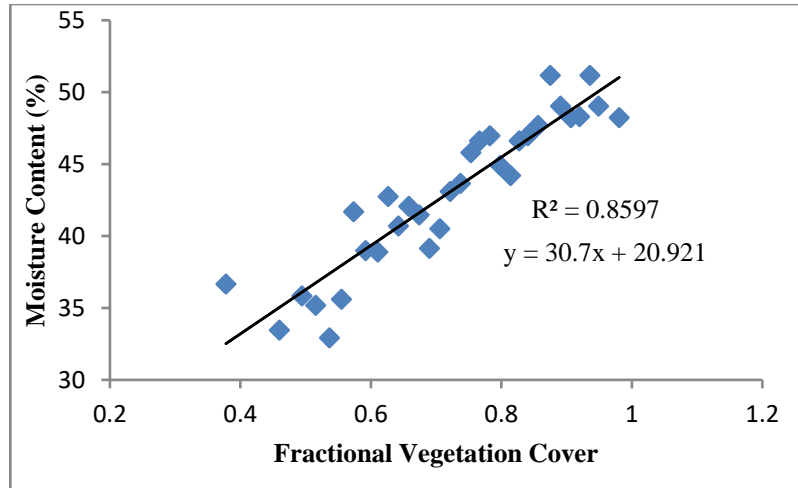
Spectral reflectance measurements is assimilated in the visible portion of spectrum (red) and near infra-red (NIR) portion respectively. The spectral reflectance is themselves ratios of the reflected over the incoming radiation in each spectral band individually. A linear relationship drawn between NDVI and soil moisture contents we get



A strong relationship drawn from NDVI and soil moisture contents with correlation $R=0.80$ with regression model value of $R^2=0.849$ which showed approximately 85% precision in the results and perfection in linear regression model along with significant correlation between normalized difference vegetation index with value of $F=56.0$.

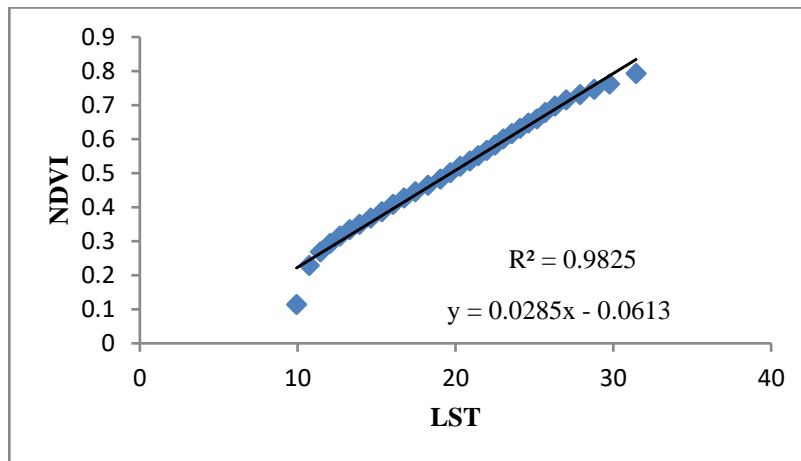
3.3. Fractional Vegetation Cover and Soil Moisture

Fractional vegetation cover parameter again showed better results than normalized difference vegetation index. The value ranged from 0.10 to 0.99 fractional vegetation cover in district Rawalpindi in the month of February 2016. A best correlation showed between soil moisture contents and Fractional vegetation cover with $R=0.9$ value along with regression model value of $R^2=0.888$ approximately 89% accuracy in the results and great fitness in the linear regression model while significant correlation with $F=238.1$ value. From above results it is clear that scaled NDVI (Fractional Vegetation Cover) showed more accurate results as compared to Normalized Difference Vegetation Index (NDVI).



3.4. LST and NDVI

Land Surface Temperature (LST) is a major variable in the physics of ground surface processes. The value of land surface temperature in the month of February 2016 of Rawalpindi district ranged from 31.43 to 8.87 while normalized difference vegetation index lies between 0.793 and 0.11400. It totally relies upon soil moisture, vegetation cover and albedo.

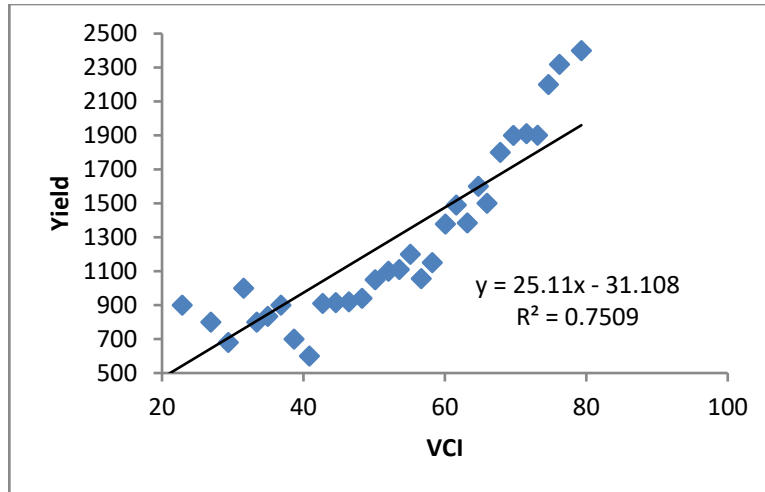


From ANOVA table, a linear relationship between land surface temperature and normalized difference vegetation index between two variables was $R=0.96$ along with $F=364.1$ and regression model of $R^2=0.924$ which shows 92% accuracy along with huge perfection in linear regression model.

RELATIONSHIP BETWEEN SATELLITE DERIVED INDICES FOR SOIL MOISTURE ESTIMATION BASED ON GRAIN YIELD FOR SPATIALLY CROP MANAGEMENT

VCI with Grain yield

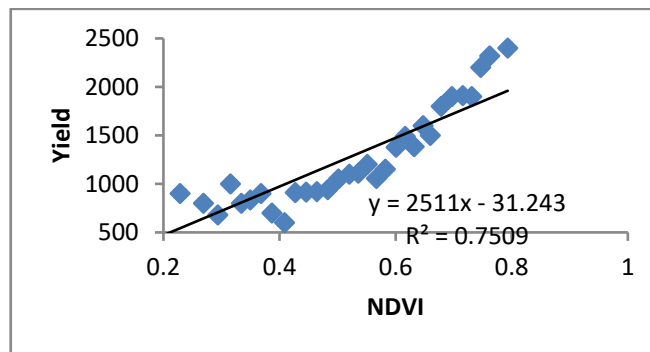
ANOVA table represented a significant interaction between vegetation condition index of Landsat8 and crop yield. ANOVA table presented a significant correlation between vegetation condition index values and yield data with $F=548$ which shows that yield varies with respect to vegetation condition index.



A strong regression drawn between these two variables with $R^2=0.948$ and correlation between them was $R=0.97$. The value of R^2 indicates the accuracy between two variables and this accuracy show the fitness of model.

NDVI with Grain yield

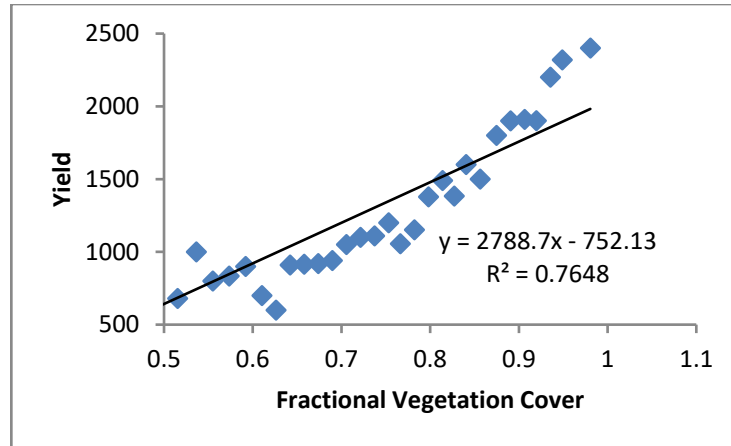
ANOVA table represented a significant interaction between Normalized Difference Vegetation Index of Landsat8 and crop yield. ANOVA table presented a significant correlation between Normalized Difference Vegetation Index values and yield data with $F=350$ which shows that yield varies with respect to Normalized Difference Vegetation Index.



A strong linear regression built between these two variables and regression $R^2=0.92$ with correlation $R=0.96$. The value of R^2 indicates the accuracy between two variables and this accuracy show the perfection of model.

Fractional Vegetation Cover with Grain yield

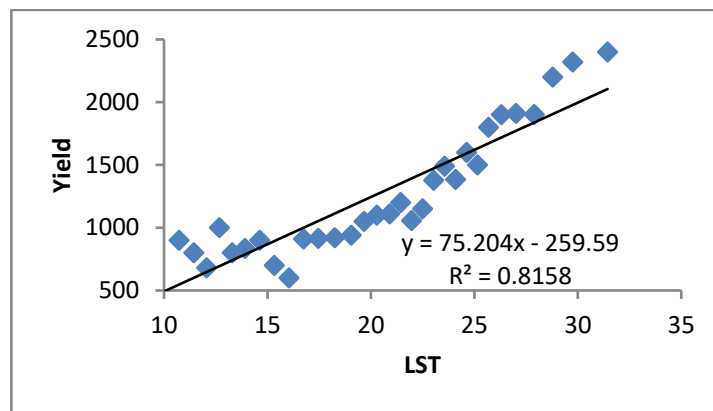
ANOVA table represented a significant interaction between Fractional Vegetation Cover of Landsat8 and crop yield. ANOVA table presented a significant correlation between Fractional Vegetation Cover values and yield data with $F=191$ which shows that yield varies with respect to Fractional Vegetation Cover values.



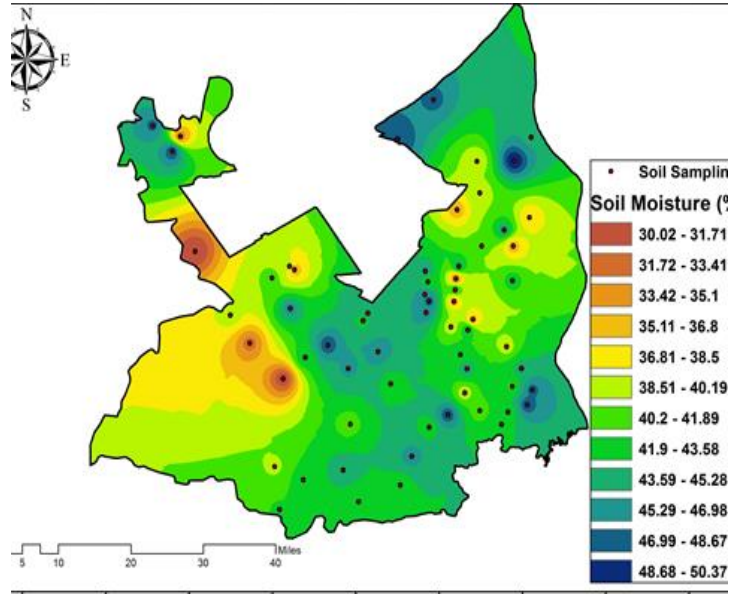
A strong positive relation built between these two variables and regression $R^2=0.93$ with correlation $R=0.86$. The value of R^2 indicates the accuracy between two variables and this accuracy show the strength of model.

LST with Grain yield

ANOVA table represented a significant interaction between Land Surface Temperature of Landsat8 and crop yield. ANOVA table presented a significant correlation between Land Surface Temperature values and yield data with $F=132$ which shows that yield varies with respect to Fractional Vegetation Cover values.



A strong positive relation built between these two variables and regression $R^2=0.81$ with correlation $R=0.90$. The value of R^2 indicates the accuracy between two variables and this accuracy show the strength of model.



Probability map of district Rawalpindi of soil moisture Suggestion

Fractional vegetation cover showed better results as compared to NDVI so in future apply Fractional vegetation cover index in triangle method to get accurate result in measurement of soil moisture contents along with spatial crop management in rainfed areas.



THEME 2

GLACIAL LAKE OUTBURST FLOOD (GLOF)

Theme 2:
GlacialLake Outburst Flood (GLOF)

Glacial Lake Outburst Floods: Impact on the Environment and Socioeconomic conditions of Hunza

Irfan Karim

Abstract

This study is based on Glacial Lake Outburst Flood (GLOF) occurrences in Hassanabad, Pakistan, over the last five years. The study examines the impact of GLOF on households and understands the indigenous knowledge along with community-based risk mitigation techniques to reduce the intensity of GLOF related damages. The asset pentagon of sustainable livelihood framework of the Department for International Development (DFID) provided the fundamental concepts for carrying out this research. In addition, this study tapped upon the approaches currently used by stakeholders to mitigate GLOF-induced hazards and the lessons for perceived cataclysm. To achieve this, primary data sources, i.e., Focus Group Discussions (FDGs); the questionnaire-based Key Informant Interviews from the households; stakeholders and representatives from NGOs were utilized, and the gathered data was analyzed using SPSS. The data division was such that quantitative information was converted into percentages and frequencies. At the same time, the primary qualitative data was used to assess the community resilience, disaster risk reduction and GLOF management. According to 74.1 percent of the total respondents, there is a significant loss of the cultivable land due to GLOF. Drinking water facilities and irrigation channels disrupted, which causes 50.3 percent of households to fetch water from outside. This scarcity has limited the agricultural yield by several folds in the past three years. The local communities have sustained by shifting from natural to social and human capital. Although the indigenous knowledge of the community suggests certain religious rituals to manage disasters like GLOF, the frequency and intensity of such catastrophes remain the subject of research across the region. The current socio-economic and environmental study is a reference for future research work.

Keywords: GLOF, Households, Stakeholders, Disaster, Socio-economic

Impacts of Climate Change and GLOF on the Livelihood of Communities in Karakorum Range of Baltistan

Dr. Ghulam Raza, Dr. Zakir Hussain Zakir, Dr. Ishtiaq Hussain, Dr. Salar Ali, Zeshan Ali²⁹, Rasheed-u-Din³⁰, Halima Ibrahim

Abstract

The communities surrounding Karakorum range faces the risks of glacier related incidents and disasters such as Glacier Lake Outburst Floods (GLOFs), avalanches, rock sliding, erosion due to raised river levels again due to melting of glaciers and ice masses due to climate change and many other factors. The possible causes of such events, risk reduction and coping or rehabilitation strategies were explored. The experiences of the communities regarding effects of climate change in terms of possible changes in rain/snow pattern, crops, wildlife, and shifting of growing harvesting seasons were explored that shows a marked difference between three decades earlier patterns and present-day patterns of cropping seasons, snow presence, average amount of water in rivers, presence and absence of wild life in neighborhood of villages etc. The local communities settled in the neighborhoods of glaciers have adopted their own kind of adaptation and coping strategies.

The impact on Socio-economic losses was analyzed by using the framework of “Sustainable Livelihoods Framework (SLF)” also called livelihood pentagon. The average household socio-economic losses in terms of human, natural and social capitals, losses of human, natural and social capital due to glacier related incidents have been recorded during the last four decades. Unexpectedly huge life loss was reported particularly in Arando Gon in 1988 where 42 lives were lost due to the glacier drifted snow avalanche flood. Perhaps this high level damage was not properly reported anywhere due to lack of access to media that time.

According to the senior respondents of local communities, the behaviors and dynamics of glaciers vary from case to case depending upon the age, the total ice-mass, the surrounded rocks and mountains, the biodiversity and life pattern of neighboring communities (human activity aspect), the orientation of the glacier and other physical factors such as precipitation, acid rain, solar flare, global warming, industrial toxicity, lightning etc. Meteorite hitting or lightning (ختم مے) **sky fire** was reported as one of the major reasons of glacier drifting and glacier lakes outbursts. As a natural behavior, the glaciers are affected due to these hazardous factors to a greater extent.

The dynamics of glaciers is a highly interesting research and study area. This is to be noted that normal physical estimations do not apply precisely over glaciers having rapid and severe temperature and pressure conditions. The industrial and human activities of the neighboring countries and regions have direct and indirect effects upon the glaciers, snow and rain patterns in this glaciated region that consequently cause anomalous and imbalance weather conditions, rapid snow melting, hazardous avalanches and Glacial Lakes Outburst Floods (GLOFs) and glacier surging.

²⁹University of Baltistan, Skardu

³⁰UNDP GLOF-II Project

Glacial Lake Outburst Flood in Pakistan: A System Thinking Based Risk Management Approach

Muhammad Daniel Saeed Pirzada³¹

Abstract

The global warming has increase the melting rate of glaciers in Pakistan's northern mountain ranges. This rapid melting has developed more than 3,000 glacial lakes, many of which have been categorized as potential dangerous glacial lakes (PDGL) that are prone to glacial lake outburst flooding (GLOF). This makes millions of people in the region vulnerable to destruction. Climate change is a complex phenomenon. This makes it difficult to predict the future events without a reasonable doubt. The analysis of the currently available large amount of scientific data can at the best help develop various climate scenarios into the future. The holistic nature of systems thinking is considered a valuable tool for complex problem solving. The host of contributing factors and their poorly understood interactions make system thinking an excellent choice for GLOF risk management in Pakistan. This paper suggests a system thinking based risk management approach for glacial lake outburst floods. A 'System-of-Systems' approach has also been discussed in the context of risk response and disaster management.

³¹SZABIST, Islamabad

Glacial Lake Outburst floods: In Pretext to Recent Unprecedented Floods in Pakistan

Jana Awez, Areeba Falak, Tayyaba Khan³²

Abstract

Nine major river systems in Asia receive their headwaters from glaciers, which act as a freshwater reserve and as a lifeline for nearly one third of humanity. The melting of glaciers in recent decades has been demonstrated by tons of evidence. As a result of glacial retreat, more and larger glacial lakes are forming at the new terminal ends, hidden behind the exposed end moraines. Due to these, there is a greater chance that glacial lake outburst floods (GLOF) will occur. Climate change is one of the major reasons for the glacial lake outburst flood. Glaciers and high-mountain ecosystems have been greatly impacted by recent warming. Specially Countries that are more exposed to climate change are more vulnerable to GLOF. Pakistan is one of the countries that is facing climate change issues. This country hosts the world's third largest glacial ice mass, and extreme weather conditions (i.e., from winters to direct scorching summers and heat waves) in the country often result in catastrophic floods, such as those seen in the second half of 2022. where unprecedented floods occurred as a result of GLOF. The objective of our paper is to evaluate Pakistan's current climate change policy and to oversee the challenges faced by authorities in getting rid of torrential floods. Did Pakistan adopt the policies needed to overcome the floods? If it did, then what are the main causes of its outburst, and where do we lack in policy implementation that needs to be changed? In this study, we assess the extent of the GLOF threat in Pakistan, its impact on the country's people, water security, and economy, and the necessary adjustments to either mitigate or prevent it.

Key Words: Climate Change, Glacial Lake Outbursts Floods, Recent Floods, National Climate Change Policy.

INTRODUCTION:

Pakistan as an underdeveloped country is already facing many challenges of weak economic performance, poor governance, and political instability and now the risk of climate change is also at its peak. Pakistan is on 5th among the list of the country's most vulnerable to climate change in the Global climate risk index German watch report 2020, which means Pakistan will be hit hard by climate change in the near future. Pakistan hosts the world's third-largest glacial ice mass after Antarctica and Arctic Circle. The constant raise in temperature as a result of climate change is causing glacial lake outburst floods GLOF that are destroying whole villages in the country.

Glaciers are one of the most sensitive indicators of climate change because they expand and contract in reaction to changes in air temperature. In response to global warming, most glaciers have been retreating at rates ranging from a few meters to many tens of meters each year, resulting in an increase in the number and size of glacial lakes, as well as an increase in the risk of glacial lake outburst floods (GLOFs).

Every country in the Himalayan region has experienced a glacier lake outburst flood event at some point. Records show 15 GLOF incidents in Nepal, 6 in China's Tibet Autonomous Region, and 5 in Bhutan.

Glaciers in the region are receding today, providing significant evidence of global climate change. If the current trend continues, the long-term depletion of natural freshwater storage would be catastrophic. Lakes typically emerge behind newly exposed terminal moraine as glaciers retreat. The

³² International Islamic University Islamabad

rapid accumulation of water in these lakes can result in a moraine dam breach. A glacial lake outburst flood is the subsequent quick outflow of massive amounts of water and debris (GLOF).

A Glacial Lake Outburst Flood, or GLOF, is the rapid outpouring of water from a lake fed by glacier melt that has formed at the glacier's side, in front, under, beneath, or on its surface. Such events can cause immense damage, with the potential to destroy infrastructure, eroding land, and even cause fatalities in extreme cases. As a result, the prevention and mitigation of glacial lake outburst floods are an important consideration for those living in glaciated regions, as well as the emergency response team.

Despite producing less than 1% of the world's greenhouse gas emissions, Pakistan's significant vulnerabilities to climate change have been highlighted by the floods every year and these catastrophic floods once again hit Pakistan in 2022. This year the country has faced extreme weather events where the country entered from winter to direct scorching summer in March which is followed by severe heat waves, fires in multiple forests, severe monsoon rains and then all of these contributed to the catastrophic floods across the country. This tragedy has shown what the country's citizens' vulnerability looks like. 33 million people have been impacted and one-third of the nation has been underwater. There are apparently close to 8 million displaced persons. The devastation from the 2010 floods was dwarfed by the enormity of the tragedy, which is unprecedented in Pakistan. In recent floods, Pakistan's estimated loss is \$40 Billion where more than 1300 people have so far died and 33 million people are homeless. Pakistan while being an agricultural country, an overpopulated country, and a country with deficient resources cannot bear such devastating disasters and also it also has enough resources to protect itself from the impacts of climate change.

The federal government and provincial governments have worked relentlessly with local, national, and international partners to oversee the extensive relief activities taking place all around the nation. But the question that comes here is if Pakistan is already at such a high risk of GLOF and Flash floods and also the country experienced extreme weather events and floods were predicted earlier then why the government did not displace the vulnerable communities before damage? Either there is a lack of any policy or law or there is a lack of coordination between state institutions or it's political and economic instability which is always the hurdle of Pakistan's every problem.

Pakistan proposed its first National climate change policy in 2012 which guided the country to curb the risk of climate change in accordance with the Paris accord. Keeping in view the increasing risk this policy was updated in 2021 "which aims to ensure that climate change is mainstreamed in the economically and socially vulnerable sectors of the economy and to steer Pakistan towards climate compatible development". Mitigating and adapting actions are considered to be the two key ways of combating climate. This policy highlights the government's ten billion tree tsunami program along with other programs such as urban greening project, the clean and green Pakistan campaign, ecosystem restoration initiative, climate resilient urban development and protected areas & national parks initiatives. This policy considered Glacial Lake Outburst floods (GLOF) and flash floods as a major issue of Pakistan and thus suggested strategies to combat these issue.

The reason why Pakistan was unable to make sure the implementation of this policy like others is the slow progress of government, lack of coordination between government institutions, political and economic instability, less attention to issues like climate change and lack of proper budget for timely action on these issues.

PROBLEM STATEMENT

Climate change in Pakistan causes the melting of ice from glaciers which increases the frequency and intensity of water resulting in GLOF

RESEARCH QUESTIONS

1. Why Pakistan is at high risk of GLOF?
2. Did Pakistan's recent unprecedented floods occur as a result of GLOF?
3. What's the response of the Pakistani government to this risk, and how are they going to curb it?

RESEARCH METHODOLOGY

Study area:

The study area of this paper is Glacial Lake Outbursts Floods (GLOF). As this paper attempted to cover Pakistan's vulnerability to climate change and its impact in form of Glacial lake outburst floods, it covered how much Pakistan is exposed to the risk of Climate change, how this risk is causing floods, and how government institutions are dealing with this risk.

Research techniques:

This research is descriptive and analytical as it uses data from the government's official websites listed in the references. The qualitative approach is used to characterize the impacts of climate change on Glacial Lake Outbursts Floods (GLOF) and the effects it is causing on the country's local community and economy. This paper discusses floods situation at different times (e.g., 2010, 2020 & 2022) and the loss and damages that cost the country. This paper also analyzed the policies framed by the government to address this matter (GLOF) using data from numerous websites, newspapers, journal articles, and publications.

GLOF IN PAKISTAN

Climate change is a fact that is occurring right now. The global weather pattern, including temperature trends, precipitation patterns, and humidity, has evolved during the last five decades. According to an ongoing study, the rate of temperature increase is 0.32 °C to 0.34 °C every decade, compared to 0.10 °C for decades after 1939. Pakistan, like a developing country, is equally affected by climate change and global warming. The warming patterns in Pakistan differ according to High-elevation locations, like Gilgit-Baltistan, have nearly double the warming tendencies as low elevations.

The temperature rise in Pakistan over the last 40 years was 0.76 °C, whether the temperature rise in alpine regions holding thousands of glaciers was 1.5 °C. The frequency and duration of heat waves in glaciated areas have also risen. Because of these factors, glacier melting has accelerated, causing glacial retreat, however some research indicates that more than 35 glaciers in the Karakorum Range are advancing with 11 extraordinary surges.

In developing countries, such as Pakistan, climate change provides a severe challenge to social, environmental and economic growth, and lead to migration inside and across national borders of Pakistan. The consequences of global climate change are already seen in Pakistan, with an increase in the frequency of droughts and flooding, increasingly irregular weather patterns, changes in agricultural patterns, a decline in fresh water supply, and a loss of biodiversity.

The changing behavior of glaciers has resulted in the formation of new lakes as well as the expansion of the volume and size of existing lakes. As a result, the likelihood of a sudden outpouring of water from these lakes, known as a Glacial Lake Outburst Flood (GLOF), has increased. The shift in rain fall pattern is another element that has increased the frequency of GLOF incidents in the region. GLOF is a catastrophic release of pressured water from a glacial lake.

The National Climate Change Policy of Pakistan also identifies GLOFs as a potential threat to the communities living in the mountain areas.

One of the dramatic results of recent atmospheric warming in the Himalayan region has been the formation of melt water lakes on the lower portions of numerous glaciers. Climate change is likely to increase some of these natural hazards, such as glacial lake outburst floods (GLOFs), which can inflict significant social and economic harm to huge populations in the Himalayan region. In the last 200 years, the Karakoram Range has had 35 devastating outburst floods.

Systematic application of remote sensing and geographic information systems (GIS) has revealed the formation of about 2420 glacial lakes in the Hindukush-Karakoram-Himalaya (HKH) Region of Pakistan, among which 52 lakes are characterized as potentially dangerous GLOF hazards.

RECENT FLOODS:

Destructive floods that have killed people and severely damaged infrastructure have been a frequent occurrence in Pakistan in recent years.

2020 Floods

Every year, Pakistan is hit by hefty monsoon rains that frequently cause flooding and devastation. The monsoon season began with heavy rains in the provinces of Sindh and Baluchistan on August 6, 2020, and continued until August 7, 2022, without much of an interruption in 2020. Massive flooding was caused in many areas of the country by 24 hours of nonstop rain.

The Sindh province's Dadu, Shaheed Benazirabad, Karachi, and Hyderabad districts all suffered greatly from these floods. Additionally, the Baluchistan province's Jhal Magsi and Jaffarabad districts, as well as Kachhi, Sibbi, Harnai, Naseerabad, and Jaffarabad districts, were impacted. According to reports, the flooding in these areas not only severely damaged the homes and infrastructure but also the standing crops.

The majority of the country was hit by yet another round of intense monsoon rains in late August, which persisted intermittently through early September 2020 and caused urban flooding in Karachi and other Sindh regions. In the Khyber Pakhtunkhwa (KP) province, districts Shangla and Swat and Charsadda both experienced extensive flooding. 41 people were killed, and thousands of people in Karachi were severely affected by the city's worst rainstorm in nearly a century. Long stretches of time without electricity were experienced by residents as urban flooding severely damaged the city's infrastructure. The second flooding spell made people's suffering worse and resulted in the eviction of hundreds of thousands of people. Despite the government's best efforts.

Most recent 2022:

Between June and August of this year (2022), Pakistan experienced an unprecedented disaster due to a combination of flash flooding, riverine flooding, and urban flooding. According to the National Disaster Management Authority, 33 million people, or one in seven people, have been impacted by the floods, including almost 8 million who have been forced to leave their homes (NDMA). Children made up a third of those who perished as a result of the floods, which have claimed the lives of over 1,700 people. Rain-induced floods, accelerated glacial melt, and resulting landslides destroyed millions of homes and

vital infrastructure, submerging entire villages and eradicating livelihoods. The nation's poverty rate is predicted to rise by 3.7–4.0 percentage points as a direct result of the floods.

Causes of recent floods in Pakistan:

Pakistan ranks among the top 10 countries worldwide most affected by climate change. The country has observed changing weather patterns, including variations in precipitation and temperatures, increased frequency and severity of tropical storms and coastal rains, glacial melt, glacial lake outburst flooding, sea level rise, loss of biodiversity, desertification, and droughts. In the coastal belts of Baluchistan and Sindh, climate impacts are observed in the increased frequency and severity of tropical storms, coastal rains, and seawater intrusion.

The National Disaster Management Authority reports that at least 81 of the 160 districts in the nation have been designated as "calamity impacted" by the floodwaters.

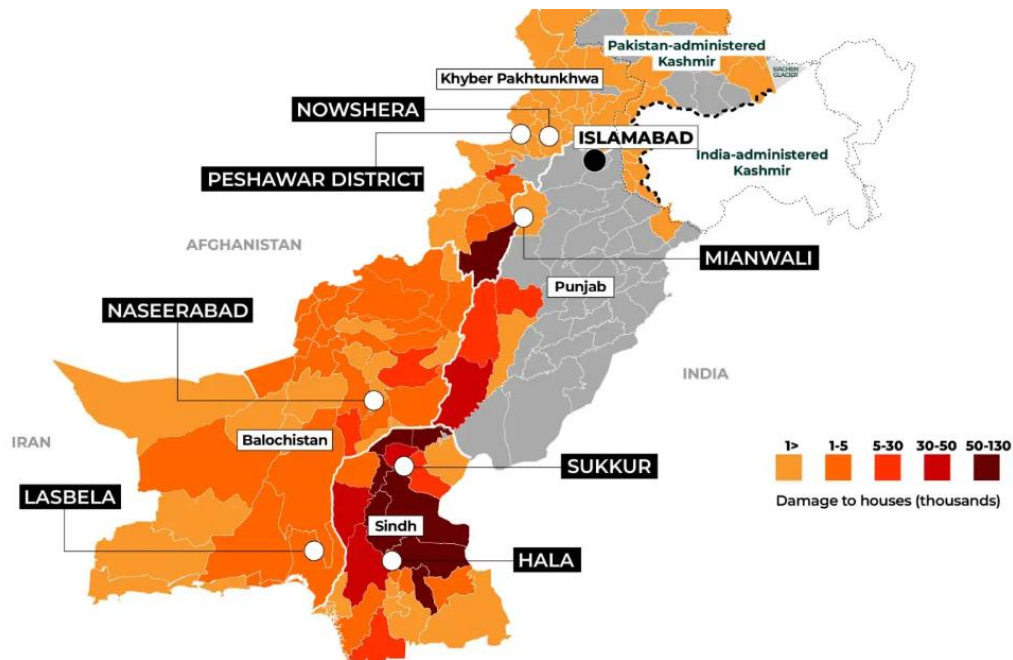


Figure 1: Districts impacted by floods 2022(source: Al Jazeera)

One of the main reason of recent floods is GLOF as ,30 glacial lake outburst flood (GLOF) incidents have so far been confirmed in the mountainous areas of Gilgit-Baltistan and Chitral in the last three weeks of July and the first three weeks of August this year as a result of "unprecedented hot weather" that persisted for several days in northern Pakistan during the summer.

Sherry Rehman, the federal minister for climate change, forewarned provincial disaster management officials in Khyber Pakhtunkhwa and Gilgit-Baltistan of oncoming heavy rains at the start of monsoon season and urged them to take prompt action to prevent fatalities from glacial lake outburst floods because these regions had experienced record-breaking summer temperatures.Chitral and Gilgit-Baltistan's summertime maximum temperatures ordinarily hovered around 40 degrees Celsius, but this year, during the months just before the monsoon season began, these regions had daily highs of 43 degrees Celsius. Due to the rapid melting of the snow and ice in the mountains as a result of recent rainfall, several glacial lakes unexpectedly burst, resulting in flooding that caused damage to bridges, homes, and other structures in these locations.

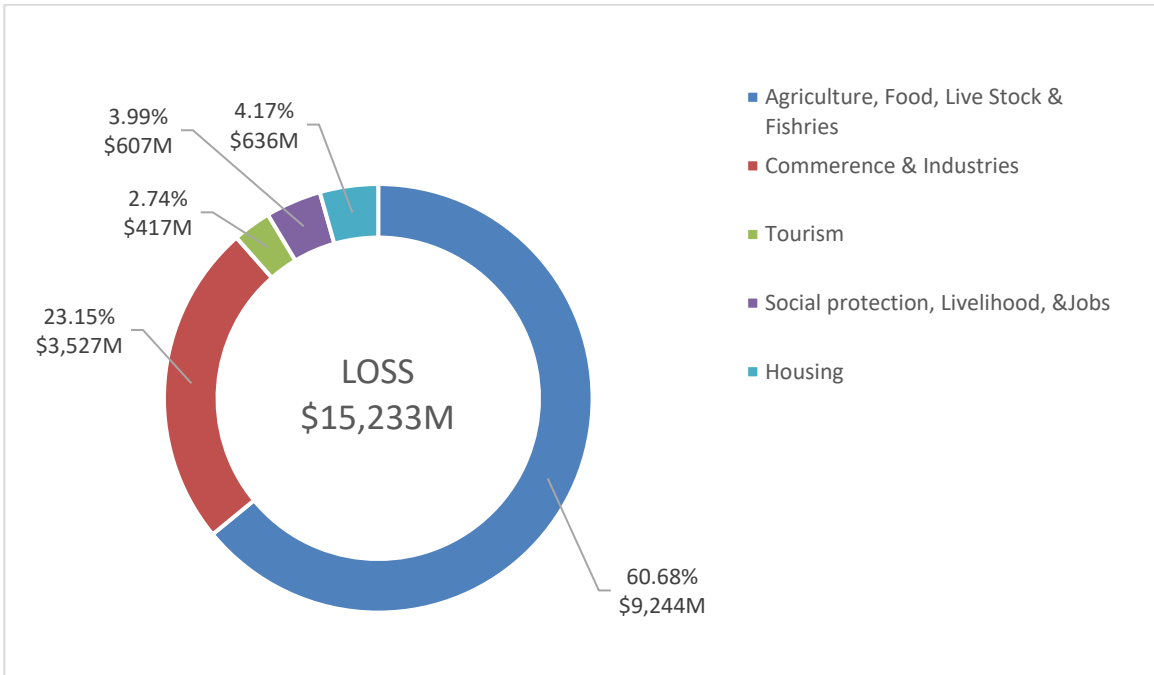
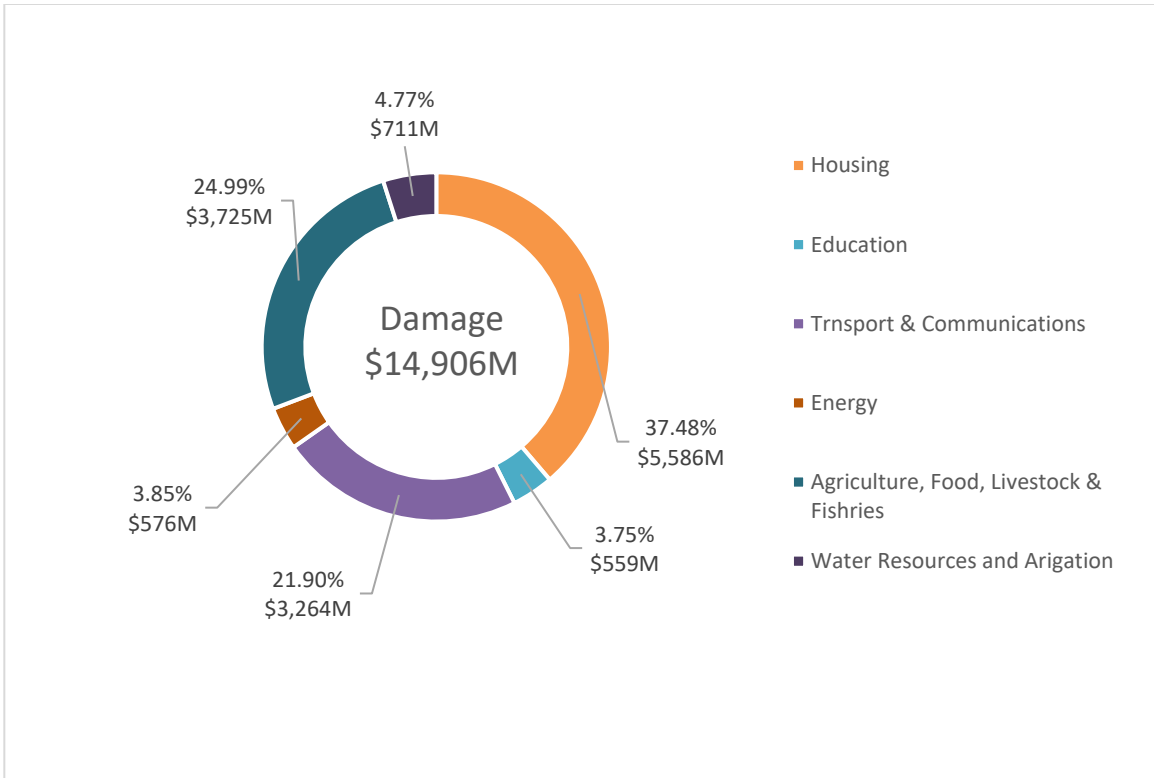
According to the Ministry of Climate Change, roughly 3,044 glacial lakes have been produced in Gilgit-Baltistan (GB) and Khyber Pakhtunkhwa (KP) due to fast melting of glaciers in Pakistan's northern mountain ranges (the Hindukush, Himalayas and Karakorum) because of rising temperature in Pakistan. "Out of the 3044 glacial lakes, about 33 have been classified as being vulnerable to dangerous glacial lake outburst floods" (GLOF). GLOF are abrupt occurrences that can cause the discharge of millions of cubic metres of water and debris, resulting in the loss of lives, homes, and livelihoods in isolated and impoverished mountain villages.

Impact of recent floods on country,s people and economy:

The floods are predicted to have a significant detrimental impact on the economy of Pakistan. Overall damages are anticipated to be PKR 3.2 trillion (US\$14.9 billion), or 4.8 percent of FY22 gross domestic product (GDP). Agriculture and industry are expected to suffer around one-quarter of the overall costs, while the services sector is expected to face almost half of the total damages. The estimated cost of recovery and reconstruction is 1.6 times the anticipated national development expenditure for FY23.

<i>Region</i>	<i>Damage</i>	<i>loss</i>	<i>Needs</i>
<i>Balocistan</i>	349B PKR	541B PKR	491B PKR
<i>Khyber Pakhtunkhwa</i>	201B PKR	141B PKR	168B PKR
<i>Punjab</i>	111B PKR	122B PKR	160B PKR
<i>Sindh</i>	1,948B PKR	2,444B PKR	1,688B PKR
<i>Cross-Provincial</i>	587B PKR	14B PKR	975B PKR
<i>Special Regions</i>	7B PKR	11B PKR	10B PKR
<i>Grand Total</i>	3,202B PKR	3,272B PKR	3493B PKR

The entire cost is expected to be PKR 3.2 trillion (\$14.9 billion), PKR 3.3 trillion (\$15.2 billion), and PKR 3.5 trillion (\$16.3 billion) for all needs. The most severely affected industries were housing, which lost PKR 1.2 trillion (\$5.6 billion), agriculture, food, livestock, and fisheries, which lost PKR 800 billion (\$3.7 billion), and transportation and communications, which lost PKR 701 billion (\$3.3 billion). PKR 1.1 trillion (\$5.0 billion) is needed for rebuilding and recovery in the transport and communications sector, followed by PKR 854 billion (\$4.0 billion) for housing and PKR 592 billion (\$2.8 billion) for agriculture, food, livestock, and fisheries. About half and fifteen percent, respectively, of the demands for recovery and reconstruction are in the provinces of Sindh and Balochistan.



Economic activity has been interrupted, lives have suffered, and poverty is anticipated to rise dramatically. The magnitude and duration of shocks will differ between places and families based on the severity of the floods and the time it takes for the water to recede, as well as their current socioeconomic status, condition, as well as the quality and speed with which relief and rehabilitation activities are carried out. Even in the best-case scenario, restoring these negative shocks to family

welfare would take time, and some losses, such as losses to human capital and loss of land productivity, may put in motion larger long-term decreases in welfare, necessitating special care.

Floods in 2010 and in 2022:

According to official statistics, similar floods ravaged Pakistan in 2010, killing more than 1,700 people and displacing at least 20 million others. The 2010 floods were riverine, which happens when rivers overflow due to excessive rain, usually more gradually. The floods of this year have been classified as flash floods, which are brought on by powerful storms that drop a lot of rain in a short period of time and because of GLOF as a result of "unprecedented hot weather" during the summer.

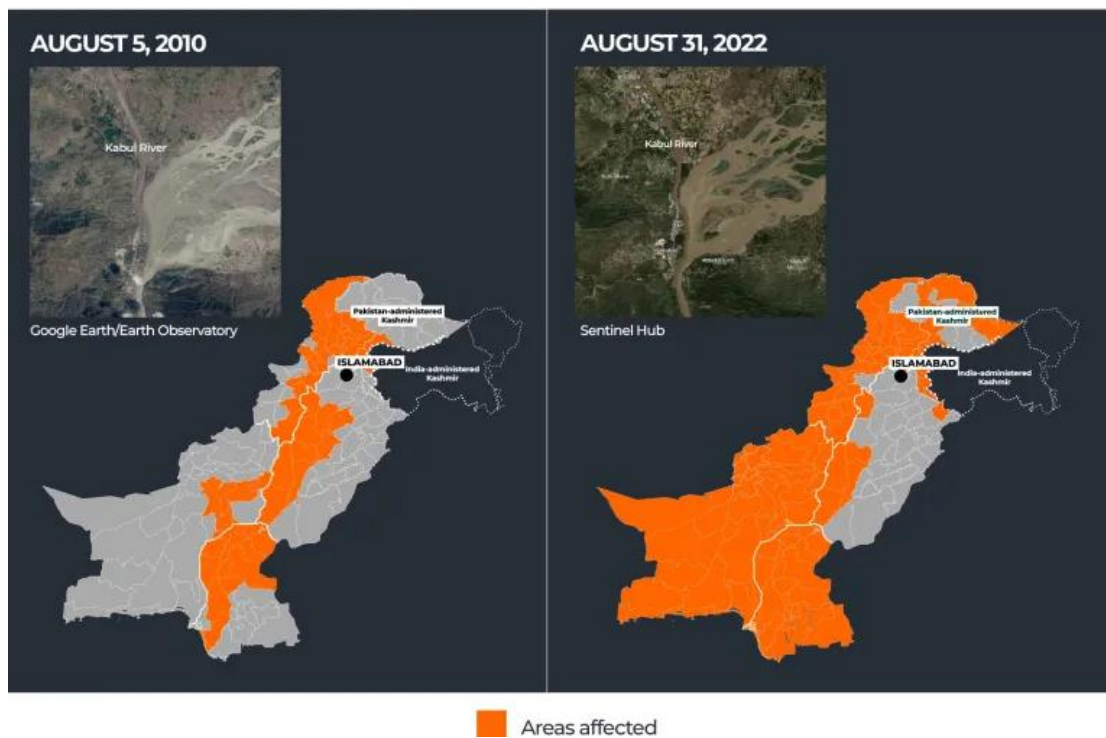


Figure 2: damage by 2010 and 2022 floods (Source: Al Jazeera)

NATIONAL CLIMATE CHANGE POLICY OF PAKISTAN

Climate change poses a serious threat to the social, environmental, and economic development of developing countries such as Pakistan. The effects of global climate change in Pakistan can be seen in the growing frequency of droughts, flooding, increasingly erratic weather patterns, and changes in agricultural practices. Keeping this in view, Pakistan updated its national climate change policy in 2021, which aims to "ensure that climate change is mainstreamed in economically and socially sensitive sections of the economy and to push Pakistan toward climate-compatible growth." The objective of this policy is to describe climate change threats to the country and to provide nature-based solutions that are necessary to be considered to combat climate change.

Extreme weather events, a continued rise in temperature, melting glaciers, droughts, and floods are some vulnerable climate change threats enlisted in the policy documentation, and policy measures are

suggested to curb these threats. In mountain areas, more frequent flash floods and landslides are occurring as a result of an increase in the intensity and frequency of precipitation, and the continued rise in temperature is resulting in rapid glacier melting and Glacial Lake Outburst Floods (GLOF). The policy measures suggested for adaptation to these floods are:

- promote and encourage the use of glacier grafting techniques in high altitude areas
- develop and maintain a sustainable Glacial Lake Outburst Floods (GLOFs) community-based disaster response and risk management system.
- set up appropriate mechanisms to monitor the development of glacial lakes and develop evacuation strategies in case of Glacial Lake Outburst Floods (GLOF) or vulnerable areas.
- establish local flash flood forecasting and warning systems in vulnerable mountainous areas.
- strengthen flood forecasting, drought monitoring, and early warning systems in the country.
- enhance capacities to address the impacts of floods, flash floods, GLOF, droughts, and so on by strengthening the relevant agencies.
- undertake the formulation and implementation of "river flood plain" regulations and laws

Framework for Implementation of National Climate Change Policy:

Following the national climate change policy, the government of Pakistan developed a framework for the implementation of the National Climate Change Policy (NCCP). This framework is a broader aspect that addresses the concern of how to adapt to the changing impacts of climate as enlisted in the NCCP. This framework provides the detailed objectives, for each sector that is vulnerable to the threat of climate change, and it covers a wide range of strategies that must be implemented in order to enhance capacities to address the impact of floods, flash floods, glacial lake outburst flooding (GLOF), droughts, and so on.

It is not possible for the country to avoid or prevent natural hazards like flash floods, droughts, and GLOFs etc. But with appropriate adaptive measures and climate resilient development work in risk prone areas, these hazards can be prevented or their impacts can be minimized. The mountains are most likely to be affected by climate change and cause floods. The following strategy and framework for implementation have been developed to overcome flash floods and GLOFs:

Objectives: To map the vulnerability of mountain ecosystems to climate change and establish action strategies for its mitigation.

Strategies: Conducting extensive scientific research in mountain areas to identify the most vulnerable and resilient ecosystems to the negative effects of climate change, and addressing identified challenges with tangible measures

Actions:

- Initiate focused research and establish a research center for scientific information on mountain areas.
- Investigate the effects of climate change and make scientific results public.

Objectives: To protect mountain ecosystems and plains from degradation and pollution

Strategies: Discourage actions that contribute to the loss of mountain ecology while encouraging those that contribute to the restoration of a livable climate at higher elevations.

Actions:

- Undertake GLOF related research and therefore establish projects to safeguard the glaciers of the northern region.
- Create a network of tiny multifunctional dams in mountainous areas to lower flood intensity.
- Sensitize and take on board the local communities for promoting ecotourism.

Objectives: To increase awareness of climate change-related natural disasters' impacts and our capacity to respond

Strategies: Improving awareness of issues related to mitigation of climate change included disasters through public participation

Actions:

- Create methods to formalize and foster robust sectorial collaboration among disaster-management sectors.
- Provide special emergency response training programs for non-profits and volunteer organizations.
- Create an integrated information system to manage temporal and spatial climate change and catastrophe risk reduction data.
- Include catastrophe management as a discipline in university curricula.

Objectives: To develop integrated hazard mitigation strategies

Strategies: Create risks zoning and mitigation techniques through management, policy creation, and law enforcement.

Actions:

- Prepare a Pakistani-integrated natural hazard zoning map.
- Identify low-risk flood zones for future land use planning.
- Identify safe sites for people and livestock evacuation in each susceptible locality.
- Encourage village resettlement/relocation outside the floodplain.
- Update river regulations to preserve streams, river banks, and other waterways from invasion.
- Universities should update their flood plain maps for a 100-year return period.

Objectives: To provide reliable natural disaster information and early warning where and when it is needed

Strategies: Developing and strengthening natural hazards early warning system for providing reliable warnings to the users

Actions:

- Update and expand the country's weather monitoring station network

- Establish local flash flood warning centers in hazardous mountain locations
- Install remote sensing and ground-based monitoring systems to track the progress of glacial lake outburst floods (GLOF)
- Create evacuation plans for sensitive locations in the event of a GLOF.
- Establish a national data center to facilitate the sharing of all climate, water, and weather data.

Progress report of NCCP:

The progress report regarding implementation of national climate change policy (NCCP) and its implementation framework was published in January 2021 by ministry of climate change which contain all the progress of government's workings and projects. Some related to GLOF and flash floods are listed as under:

1. **Disaster risk reduction funds** were provided to GB and KP to curb with flash floods and GLOF.
 - Adaptation fund for reducing the risk of Glacial Lake Outburst Floods in Northern Pakistan(GLOF I) is \$3,906,000
 - Funds for scaling-up of glacial lake outburst floods(GLOF) and reducing its risk under GLOF II was GCF\$20,829397
 - Funds provided PKR 230 Million for the establishment of flood forecasting and warning system for kalpani Nullah Basin, Mardan, Khyber Pakhtunkhwa.
 - Construction and improvement of irrigation infrastructure including floods protection work, channels, roads, tube well in district Sawabi is PKR 710.897 million
2. **Scaling-up of Glacial Lake outburst flood (GLOF) risk reduction** in northern areas of Pakistan (GLOF II): this is four years' project for "reducing risk and vulnerabilities from GLOF in northern Pakistan from March 2017 to December 2021. The green climate fund contributed for this project is US\$ 20.829 million. GLOF II will cover 10 districts, benefiting 29 million people or 15% of Pakistani population.
3. Enhance community local and national level urban climate change **resilience to water scarcity, caused by floods and droughts** in Rawalpindi and Nowshera. The amount provided for this project for adaptation is US\$6.049 Millions
4. Recharge Pakistan: this project is initiated for building Pakistan's resilience to climate change through Ecosystem-Based adaptation for integrated flood risk management. Funds allocated for this project from 2019 to 2029 cost USD 150 Million
5. From 28 August 2015 to 31 Aug 2019 Rs 6641 Million funds were provided by the Asian development bank for a flood emergency reconstruction and resilience project in AJ&K
6. ECNEC on 26th March, 2020 approved Rs332.246 billion for national flood protection plain IV (NFPP IV)
7. World bank approved \$300 Million for Pakistan to build resilience to natural disasters and health emergencies like floods, droughts, etc. in Dec 2020.

Challenges Pakistan is facing in Policy Implementation:

Pakistan always faces challenges when it comes to policy implementation and it is because of both structural reasons and Pakistan's current situation. This country has always been turbulent both politically and economically and thus economy, stability and security have been the mainstreams of the government's focus. Risks like climate change are increasing with the passage of time because of less attention from the government's end and these risks then turn into catastrophic hazards which further increase the economic burden on the country.

Fewer shares in Budget- Pakistan is continuously on the top of the list of countries that are prone to the risk of climate change but still the government spending on this matter is not apparent enough. The defense budget occupies a major part of the national budget despite of its weak performance in other sectors. The budget for the financial year 2020-2023 is 9.5 Trillion rupees where 58% of the total budget is occupied by loan repayment and defense while 42% remains for the development, health, and education sectors as shown in figure 2. Thus due to the lack of government attention and lack of availability of resources such policies are hard to get implemented properly.



Figure 3: Pakistan's Budget 2022

Internal stability is another big challenge for the Pakistani government when it comes to working on issues that are considered secondary. Because of internal political instability, Pakistan can pay very less attention to issues other than policies, political parties or traditional security threats. Recently in 2022 when floods badly hit the country the officials were not able to evacuate the communities before loss because the country was facing severe instability issues.

Secondly, one party comes and takes government and make policies but soon another government comes over all old policies are considered worthless. NCCP was updated by Imran Khan's regime but before it can be implemented properly his government was ousted and the new government had to bear the brunt of this flood

The coordination between institutions of government is also not strong enough to make and take quick action that is the need of the hour. Government notifications and actions come through long and slow processes that thus communities pay the cost in the form of lives and properties.

Furthermore, issues like corruption and mismanagement play an important role in the lack of policy implementation in all disciplines

CONCLUSION AND RECOMMENDATIONS:

In Northern Pakistan, the Hindukush-Karakorum-Himalayas (HKH) ranges provide the world's greatest store of snow and glaciated ice outside of the Polar Regions. The confluence point of three significant mountain ranges in the world is also located in Pakistan, with elevations ranging from 366 m.a.s.l. to 8611 m.a.s.l. The snow and ice in this region allow an abundance of water to flow into the Indus River and its tributaries, contributing to a large agricultural area in the downstream part of Pakistan's agrarian economy.

The sensitive alpine terrain is particularly exposed to the threat of global warming and climate change. Pakistan faces more floods every year severe than past as a result of Glacial Lake Outburst Floods (GLOF). The frequency and intensity of these floods are increasing, and the government is unable to effectively address this issue. The government's attention or response to this risk is less in theory and almost negligible in practice. If the speed of government for such serious matters will remain the same so Pakistan will never be able to coup up with GLOF in the future.

Floods in 2010 were severe but one in 2022 was catastrophic and one-third of the country was under water destroying agriculture, livestock, businesses, houses, means of transportation, and much more. Much severe floods can hit the country if any action is not taken timely as it's still not too late to address climate change and many issues rising from it.

There is a need to increase High-resolution knowledge, coordination, and capacity building among target communities for preparedness and risk reduction. High resolution satellite data combined with ground information can be used to successfully monitor these lakes on a regular basis in order to decrease flood risk hazards in the future.

Climate change must be examined more thoroughly in order to deal with the extent of its impact on the glacial environment, particularly in GLOF-prone areas. In distinct river basins, detailed investigations of hot point GLOF lakes should be conducted.

To provide a complete policy framework in the face of increased global warming, hazard and risk assessment analysis, as well as risk mitigation techniques, are required. Non-structural interventions include hazard modeling and monitoring of GLOF areas using techniques such as remote sensing and hydrodynamic modelling in conjunction with ground surveys for better risk mitigation and early warning.

And the most important thing government needs to do is focus more on practice and less on theory because National Climate Change Policy 2021(NCCP) is a landmark policy and covers every aspect theoretically. Action plans provided under the framework made for the implementation of this policy are also incredible but practically we are not able to save local communities in vulnerable areas and cannot ease the economic burden of the government at the time of natural hazards such as flash floods or GLOF, it means we should focus on the implementation of these policies in order to get fruitful results and reduce the risk or prevent our communities from this risk

Probability of glaciers lakes outburst flood in Hunza, Pakistan

Muhammad Saifullah, Omer Farooq³³, Adnan Ahmed Tahir³⁴

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Abstract

Glaciers lakes outburst flooding becomes a challenge in high mountain of Asia. Due to warming environment, the glaciers are retreating and surging increasing trend in this Region. The present study aims to investigate the glaciers lakes using GIS and Remote Sensing. Through satellite product, the combination of different bands and ground truthing, lakes mapping was estimated. This research work also aimed to identify the water body considering different thresholds of areas using Sentinel 2B product. Considering the different socio-environmental factors, the lakes probability was determined. The attribute table is consistent on area, volume, and slope. First lakes were categorized into high, low and medium probability. The highest score bases on probability approach were shisper lake, which is currently event also occurred. The current study will help policy maker to address the current challenge of GLOF through proper monitoring.

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Glacial Lake Outburst Floods and Climate Change in Pakistan

Asad Abbas, Ali Abbas, Ali Danial, Musawar Hussain, and Ali Bin Khalid³⁵, Shahbaz Nasir Khan³⁶

Abstract

Pakistan has largest number of glaciers outside poles, approximately 7000 out of which 3044 have glacial lake. According to an estimate about 33 lakes have been identified as prone to GLOF (Glacial Lake Outburst Floods) event. GLOF are accidental event causing eruption of millions cubic meters of water along with debris, resulting lives, infrastructure and economic losses. According to PMD (Pakistan Meteorology Department) there are about 30 events of GLOF have been reported from July and August of this year, particularly in Chitral and G.B areas. There are different causes of GLOF such as earthquake, climate change and temperature rise and breaking down of moraine dams etc. Rising temperature and climate change are causing numerous impacts globally, from sea level rise to droughts, floods, heatwaves etc. Due to climate change induced global warming, there is rapid melting of glaciers in northern areas of Pakistan such as Gilgit Baltistan and KPK (Khyber Pakhtunkhwa) endangering about 7 million population of which 26 percent population is already under poverty line. GLOF events also contributing to water security issues as we don't have capacity to store melted water. According to a research glacier are losing about foot and half of ice since 2000 and climate change have significant role in this event. People residing within 20km are more vulnerable to GLOFs. Measure such as early warning system, installation of latest weather stations and rain gauge systems should be applied in remote areas for surveillance and management of GLOF.

Key words:

GLOF, Climate change, Global warming, Sea level rise, Early warning systems.

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Geophysical Investigation of Subsurface Glacial Lake Outburst Flood Lake development at BindoGol Valley under Changing Climate, Pakistan

Umair Bin Nisar, Athar Hussain³⁷, Sarfraz Khan³⁸

Abstract

Glaciers are direct indicators of climate change. Increasing temperatures throughout the world have resulted in glacial melting. The rapid glacial melting triggers several glaciological hazards in mountainous communities of the world. Pakistan is home to three mountainous ranges Hindukush, Karakoram and Himalayas. It is an important beneficiary of third pole as head water of its major rivers lie in that region. Climate contributed temperature and precipitation has triggered several glaciological hazards in mountainous regions of Pakistan. Glacial lake outburst flood is a growing threat in mountainous communities resulting in damage to infrastructure and livelihood. The study area is BindoGol Valley glacier in Chitral region, KPK province of Pakistan. The area has experienced repeated GLOF events in recent years.

The results are achieved by integrating meteorological (temperature, precipitation) and geophysical (Ground Penetrating Radar (GPR)) data to identify glacial architecture and possibility of GLOF lake development. Several moraines filled crevasses were identified (from GPR) mostly towards the center and south of the study area. Some of these crevasses were connected to the surficial running water channels that were also detected by GPR.

A dense network of cavities was identified towards southeast of the glacier, despite being shallow, these cavities could facilitate the development of GLOF lake. The study indicates a good relationship between geophysical (presence of crevasses and subsurface cavities) and meteorological (variations in temperature and precipitation) data for the identification of source for the accumulation of larger volumes of the water possibly resulting in GLOF events.

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THEME 3

WATER POLLUTION & WASTE WATER MANAGEMENT

Analysis of School Based WASH (Water sanitation and health sciences) Facilities, Implications on Children Behavior and Health coupled with Policy Framework for enhancing cognitive learning in children.

Nayab Raza³⁹, Mehreen Raza Sikandar Bakhat, Muhammad Rizwan, Zaryab Raza⁴⁰,

Abstract

United Nations Sustainable Goals. 6 guarantees an unbiased and even access of water and basic WASH facilities but, relentless reality is polar opposite where a stellar portion especially children are devoid of basic necessity facilities, especially in Pakistan. The most vulnerable group i.e children deprived of WASH facilities. The main objective of study was, a WASH survey was conducted in two school settings i.e., Mehran and Sindh primary schools, using 100 forms comprising 21 Closed-ended questions directly linked with WASH facilities. The response was gathered from both boys and girls to maintain equity. Survey questionnaires are drafted as per international guild lines. The survey focused on four dimensions: Handwashing, toilet, drinking water facilities, and Hygiene practice showing average % responses of boys to girls as 17.4:20.3, 29:14.6, 33.6:21, and 20.6:25.8, respectively showed the condition of mentioned dimensions improved in Mehran School rather than that of Sindh School. Fluorescence microscope that confirmed the presence of various bacteria species namely *Shigella*, *Escherichia coli*, *Vibrio*, *Salmonella*, *Cryptosporidium*, *Staphylococcus* spp. Conclusively, there is a dire need to upgrade the WASH policy parallel to current scenario and need of society to lessen the severity of the problems, especially children facing in developing country like Pakistan.

Keywords: SDGs, Water, Sanitation, Hygiene, Primary schools, WASH policy

1. Introduction

In developing countries, diarrheal disease is one of the leading causes of children dying under the age of 5 years. About 95% of diarrheal disease occurs in south Asian regions and sub-Saharan regions where the children mortality rate of under 5-6 years old is 28%. Globally, around one in every five child deaths are due to diarrhea. Currently, Pakistan is in 6th position right after Ethiopia in the global ranking of cause-specific deaths of children under the age of 5 due to diarrhea. Various studies and research showed that poor WASH facilities and polluted environments contribute to the most of health issues in children. Due to inadequate and unsafe water, unimproved sanitation, and poor hygiene practices among people particularly children drag them into infectious disease resulting in more than 2-3 million death every year. Primary Schools are hotspot for the spread of infection due to poor WASH practices.

UNICEF initiated the WASH (water, sanitation, and hygiene) Programme in school under auspicious efforts of the united nation framework (2008-2015) under emblem “to promote sustainability and harmony, peace and security in school” (Evaluation of WASH in schools, 2013). WASH (water sanitation and hygiene) promotion in school to provide basic facilities to children who must have adequate water, sanitation, and hygiene, safe and sufficient water supply, proper handwashing facilities, improved toilet services for boys and girls separately. WASH facilities in the school are an integral part and vision of UNICEF and WHO in world for all children who want to go to schools and get an education, so that our children in the future could grow, learn, and thrive in a competitive world (Abanyie et al., 2021). Similarly, in Pakistan WASH facilities are not up to the mark and adequate for

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school children especially in co-education where there is a dire need for separate washrooms and basic facilities for girls. Furthermore, according to estimation, every day 680,000 children miss their school due to illnesses that are directly or indirectly related to water. This term project will analyze challenges and barriers in primary school coordination for WASH in primary School, Jamshoro also determines the responsible factors to implement and inspect WASH services (Desye, 2021). The purpose of this project is to design a model for the provision of WASH service in Schools and aware the stakeholders to improve coordination at the national and local levels. Additionally, this term project intends to catalyze to increase collaboration for innovation, cost-effectiveness, and sustainability of WASH in Schools keeping the monitoring and evaluation compulsory. There are some basic indicators used are to measure the WASH facilities at schools (Howard, 2021).

Personal Hygiene

The lifelong foundation's concern for the maintenance of personal hygiene is put down in childhood, which is essential for a well-being childhood, for a healthy maturity, and the growth of optimistic values about health and the use of health service area (Sarkar, 2013). In a recent study, a significant association between intestinal parasitic infections and poor hygiene is validated which indicates the efficacy of WASH practices in the prevention of those infections (Tambunan & Panggabean, 2021). Children's hygiene is the best tool to be considered for improving community strategy and intervention practice to handle many infectious and communicable diseases (Albashtawy, 2015). Personal hygiene affects the children during the growth period and its development (Ahmadu et al., 2013; Oyibo, 2012; Sarkar, 2013; Vivas et al., 2010). Infections to school children are considered to be one of the major problems. The major causes of infections are inadequate and contaminated water and unimproved sanitation poor hygiene practices. Skin, gastrointestinal, dental diseases all are directly or indirectly associated with poor personal hygiene. (Ahmadu et al., 2013; Assefa & Kumie, 2014; Oyibo, 2012). Children's hygiene contains regular clean uniform, good oral care, hand washing, trimming, and clean nails and hair, etc must be practiced. It should be maintained under maternal supervision and controlled at school by the school's dedicated staff.

2. Clean water and improved sanitation

A report by WHO & UNICEF directs that more than 663 million individuals lack access to safe drinking water and 159 million people depend on surface water for consumption. (Supply & Sanitation Monitoring, 2015). According to UNICEF report 2016, only 57% of schools in the under developing countries had adequate drinking water facilities (Unicef & World Health, 2018). Until now primary schools in many developing countries have lacked WASH services, with potentially harmful effects on school children's health. There is a need to separate the feces from the water sources, therefore decreasing the risk of fecal pollution (Andres, Briceño, Chase, & Echenique, 2017). Contaminated water causes gastrointestinal diseases such as diarrhea which turn out to be a major health concern. Diarrhea is silent one of the silent killers of children under the age of five (W. H. O. Unicef, 2013). The WHO/UNICEF report state that a school with improved sanitation, adequate water, and hygiene (WASH) has a sufficient and appropriate number of latrines that are safe, clean, private, and gender-separated; hand-washing facilities with soap and water; and hygiene awareness in the school are mandatory (Unicef, 2016).

3. Toilet Facilities

Toilets must be clean, with sufficient handwashing and water facility at schools. A cleaning and maintenance routine must be operational all the time (Bartram, Sims, & Chartier, 2009). The cleanliness of the toilets is linked with acceptance or refusal by the students. The poor school toilet quality is linked

with toilet refusal or postponement in children which leads to symptoms of bladder and bowel dysfunction (BBD) (Jørgensen, Breinbjerg, Rittig, & Kamperis, 2021). Toilets must be open to the whole school, including children & teachers keeping separation and privacy intact, and distance must not be greater than 30 meters from all classes and offices. Open defecation, which directly impacts human health by increasing exposure to fecal pathogens. Children need to remain fit and healthy. For this, they need to drink 8 to 10 glasses of water daily during the whole day along with proper excretion and oral care (ERIC). Scarce liquid intake and scarce toileting services can lead to problems like constipation, urinary tract infections (Meadow, 1988).

4. Handwashing facilities

Hand washing's goal is to clean the hands and avoid cross-spread (Kaltenthaler, Waterman, & Cross, 1991; Larson & Committee, 1995; Rotter, 1999). Handwashing without soap is correlated with increased incidents of diarrhea (Almoslem et al., 2021). Good hand hygiene is significant in infection control that varies from person to person, whose absence can be a reason for the spread of gastrointestinal and respiratory infectious diseases (Goldmann, 2000). 12% of all hospitalized children aged 0–14 years are due to infectious disease (From the Health Protection Agency, 2006). Hand hygiene is important in primary schools to avoid the spread of infectious disease and is a key to controlling contagious diseases like plague, influenza, etc (Chittleborough, Nicholson, Basker, Bell, & Campbell, 2012). Highlighting hand hygiene to lower the spread of infectious disease could improve the attendance of teachers and children in schools, and might also possibly prevent secondary infectious disease in the public, decrease health facility costs and lower the financial burden on families (Manandhar & Chandyo, 2017). The exercise of handwashing positively impacts an individual's health and his role in society as well (Hoque, Mahalanabis, Alam, & Islam, 1995; Hoque, Mahalanabis, Pelto, & Alam, 1995).

5. Key Challenges in Pakistan regarding

Water sanitation and hygiene (WASH) are pivotal for human existence on this special blue planet. WASH, directly and indirectly, caters to all spheres of life ranging from health, nutrition, and sustainable human development to the progress of a country (Zaidi, Mohmand, Hayat, Acosta, & Bhutta, 2013). A tool to manage and provide adequate services and facilities of WASH that is a “comprehensive WASH policy” is missing. Pakistan is one of the third world countries which is confronted with a variety of nutritional health hazards and water-related issues and a list of water-based, water washed, water-borne diseases still prevails in the country which is eradicated in the developed countries (Baig et al., 2018). Countless WASH-related diseases like Poliomyelitis, Dengue, Cholera, Ebola, etc. are peculiar to underdeveloped countries hindering the progress of our country since its inception. Plenty of water is available but hunger and poverty make the country incapable to utilize it (Javeed, 2020).

6. 1.6 Literature on a survey of water, sanitation, and hygiene (WASH)

Table 1 shows some of literature review or studies which already have done in previously for survey and intervention purpose in school with different sample size and key finding.

Table 1. Literature on a survey of water, sanitation, and hygiene (WASH) among schools

S/No	Study Design	Country	Sample Size	Key Findings	Author
1	Descriptive survey	Nigeria	300 primary schools	Improved WASH (water sanitation and hygiene) facilities can be achieved through proper intervention and learning development among children's.	(Sarkingobir, Sharu et al. 2019)
2	Cross-Sectional Study	Tanzania	84 primary schools	Poor planning, low technical capacity and poor funding are main reason for barrier in WASH facilities.	(Antwi-Agyei, Mwakitalima et al. 2017)
3	Cross-sectional study	Nigeria	428 pupils	Adequate WASH resources may have positive impacts on maintenances of WASH facilities in schools.	(Mogaji, Dedeke et al. 2017)
6	Cross sectional survey.	Nigeria	12 public school	There are 8 WASH variables considered in this study which concludes that negative WASH practices are associated with combination of both chronic and acute malnutrition.	(Danjin, Sawyerr et al. 2021)
7	Cluster-randomized trial	Ethiopia		The main finding of this survey is to reduce the chlamydia infection among children by providing comprehensive hygiene education.	(Wittberg, Aragie et al. 2021)
8	Cross-Sectional Survey	Nicaragua	526 schools	One time cross sectional studies conducted in government school where efforts should be	(Jordanova, Cronk et al. 2015)

				made to regularly check the WASH facilities	
9	Cross-sectional survey	Nepal	-	For children health and well-being, Provision of WASH awareness in communities is best way to curb with disease	(Shrestha, Sharma et al. 2017)
10	Cross sectional survey	Ghana	300 children	There is dire need of basic hand washing education among children through curriculum	(Dajaan, Addo et al. 2018)

2. Methodology

2.1 Study design

The study was a cross sectional study. The purpose of this study was to assess the effect of school-based WASH facilities and their impacts on children learning. In Fig1 provides a main objective of this WASH intervention.

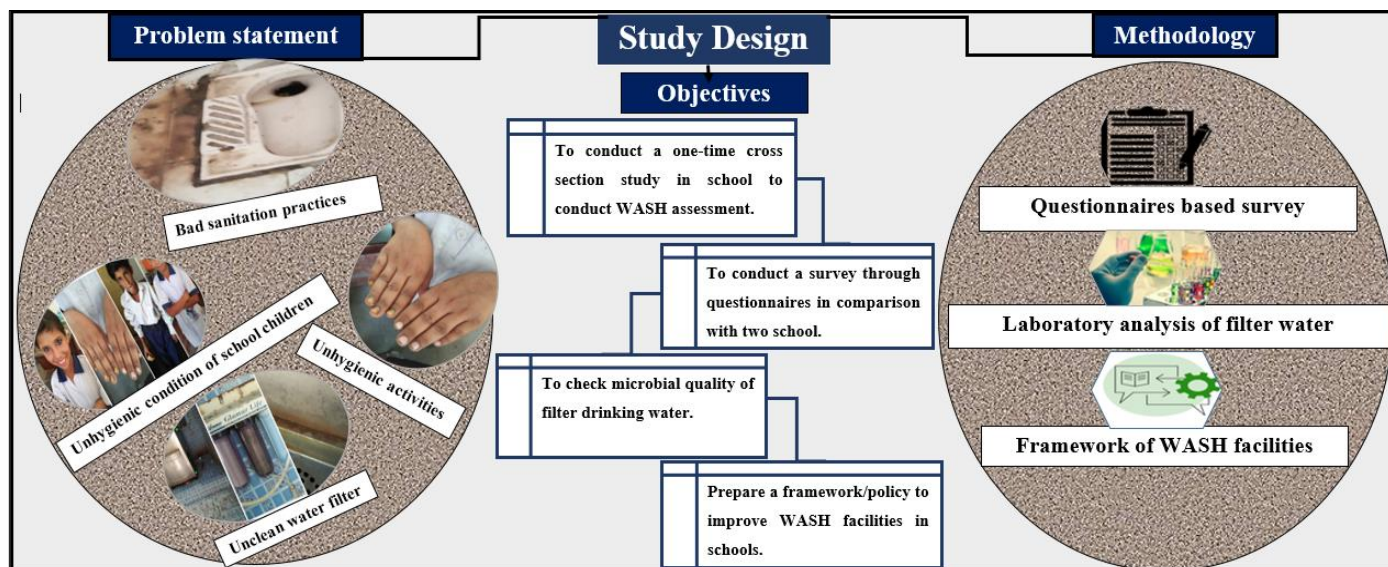


Figure.1 the study design of school-based wash facilitates and its key objectives

7. 2.2 Study area and participants

The Assessment of Water, Sanitation, and Hygiene (Wash) Facilities in secondary schools of Jamshoro (Sindh) was conducted on 9 august 2022. The study consists of a questionnaires' based survey with random analysis, from 9th, 10th grade. The study areas are Mehran and Sindh campus school by the proper authoritative signature of documents for entry in school by Dr. Jamel Ahmed. We recruited a total sample of school children in the target age range (12–15 years) because at that age children have

more sensibility regarding answers either true or false. Below the Table2 shows the socio demographic characteristics of overall study design. With the questionnaire, we also took photos for the support of our documentation. Along with the survey, laboratory analysis of filter water was also done in the USPCASW laboratory to check the parameters of drinking water at school's settings.

Table. 2 Social demographic characteristics of the study population

District: Jamshoro Taluka: Kotri		Mehran Secondary School: 25.4084° N-Latitude Sindh Secondary Campus School: 68.2605° E-Longitude	
Variables	Population in Target schools	Mean (N)	Population (%)
1. Mehran secondary school	Boys: 787 Girls: 853 Total = 1640	Mehran: 820 N	Boys: 47.98 Girls: 52.01
2. Sindh secondary school	Boys: 1101 Girls: 789 Total= 1890	Sindh : 945 N	Boys: 58.25 Girls: 41.74
3. Total children interviewed	Mehran secondary school Boys = 25 Girls = 25 Sindh secondary school Boys = 25 Girl =25		

8. Sample size and analysis technique

The sample size is randomly chosen 100 children in both schools. Analysis was based on three types as shown in fig2 as observational, experimental, and theoretical study.

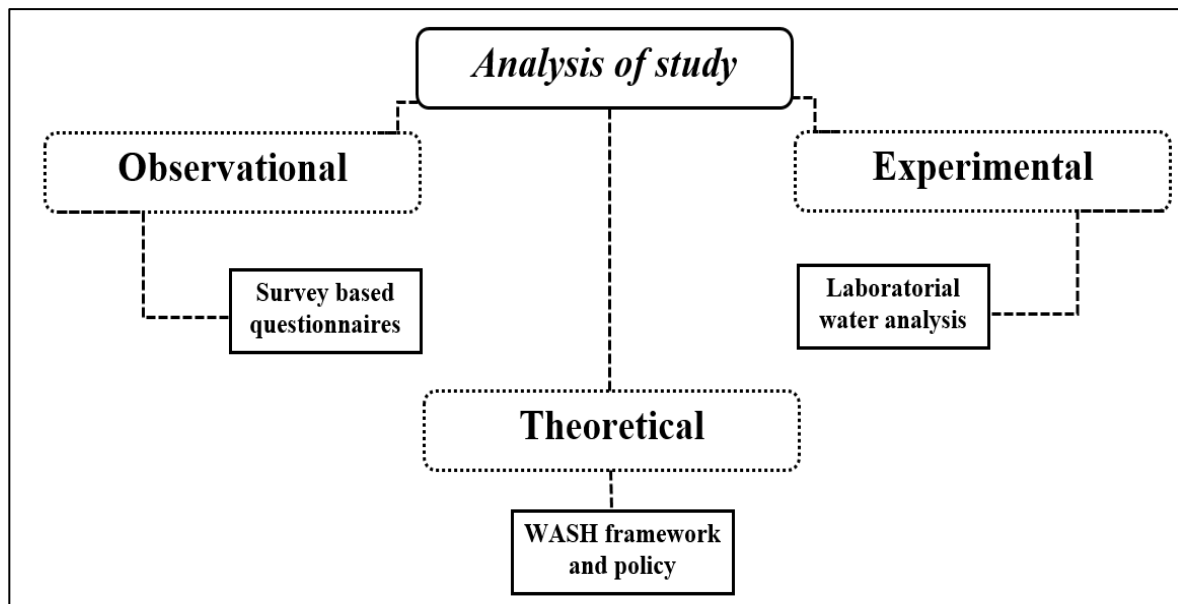


Figure.2 Analysis of study based on observational, experimental and theoretical.

2.3.1

Survey based questionnaires

The survey consists of a total 21 Closed-ended questions, out of them, 20 questions directly linked to enquire the provision of WaSH facilities in the school. Total 100 forms containing Survey questionnaires are made by following the WHO, UNICEF, and international guidelines to gather the respective responses of boys and girls. The aim of questionnaires is to collect the core data to check the presence of WASH facilities in the school. This data might be proved as instrumental for formulation of a comprehensive WASH policy and its implementation in Sindh Schools. The survey questionnaires conveying the commitments of SDGs relevant to WASH with Several SDG targets contain WASH commitments or rely on the availability of WASH facilities, including targets under SDG 3 (good health and well-being), SDG 4 (quality education), and SDG 6 (clean water and sanitation). SDG 6 expresses commitment to water and sanitation for all (SDG targets 6.1 and 6.2), while indicators relating to SDG target 4. On education facilities have associated indicators for the provision of WASH facilities in schools.

Table. 3 Water sanitation and health sciences (WASH) based Survey Questionnaires

Survey Questionnaires settings	Mehran school				Sindh school			
	Boys		Girls		Boys		Girls	
Responses %	Yes	No	Yes	No	Yes	No	Yes	No
1. Handwashing facilities								
Do you wash your hands after attending the toilet?	12	87	17	75	13	77	18	78
Is there separate facility of toilets for both genders?	9	85	12	81	14	85	12	81
Does toilets have proper wash basins??	20	67	35	56	35	67	35	69
Is there soap available to for handwashing?	9	87	5	84	12	87	35.5	90
Does sufficient tap and shower connections present in school's vicinity?	5	88	10	78	13	88	1	95.4
2. Toilet facilities								
Are the toilets at your school clean?	40	56	13	80	9	67	5	78
Do you wash your hands after returning from school??	35	46	5	87	27	61	10	78

Are there sufficient people to clean and maintain toilet?	45	55	35	55	34	51	16	76
Does the toilet contain adequate light connections and ventilation?	23	45	19	32	30	45	29	39
Do you use sanitizer after washing hands whenever you attend toilet?	2	89	1	91	4	79	3	61
3. Drinking water facilities								
Does the school have sufficient filtering plants of drinking water?	65	20	15	74	20	72	29	62
Does the water source away from toilet etc. in order to avoid any contamination?	40	60	28	65	30	62	25	60
Do you think that water is clean and safe to drink?	59	13	61	15	58	9	63	17
Do you know about the water-borne diseases?’	3	79	2	83	2	79	4	69
Do you think that unavailability of clean water and toilet increases absenteeism?	1	89	1	81	3	92	2	88
4. Hygiene practice								
Do you trim your nails regularly?	10	70	18	71	12	75	23	61
Do you wash your hands and use sanitizer after any activity at school?	15	85	25	55	21	57	42	35
Are you familiar with the term “personal hygiene”?	4	85	6	76	5	78	8	79
Do you brush your teeth twice a day?	49	13	45	15	32	13.5	49	25
Does your teacher aware you about the importance of handwashing and using sanitizer?	25	45	35	47	32	49	26	61

2.3.2 Laboratorial analysis of water

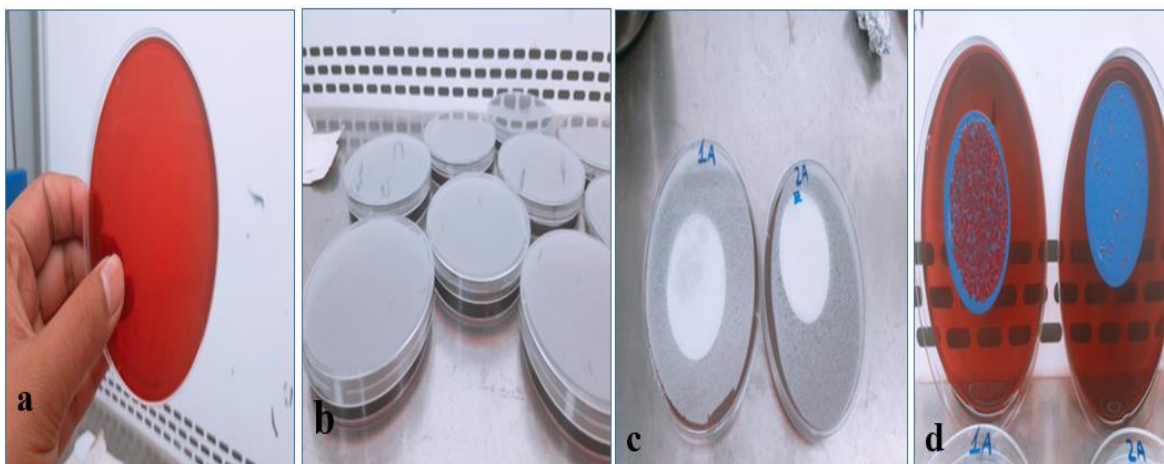
The sample of drinking was collected from each school's filtering machine to check the efficiency of the filter plants. Some physiochemical parameters and microbial analysis were conducted through APHA standard methods (WEF) and Hach kits. According to the water quality monitoring guidelines of water pollution act describes that parameters for quality for drinking water that is to be used in society (Ustaoğlu, Taş, Tepe, & Topaldemir, 2021). Table 4 presents the physiochemical parameters of both school filters along with its permissible values of described in WHO and US-EPA guidelines for drinking water. These parameters need to be analyzed for the determination water quality that is best to use in schools. The various physico-chemical and biological parameters are related to each other and the overall quality of water depends upon the deviation from the permissible range. So, the turbidity in Mehran and Sindh School is 10.7 and 9.0 respectively which is higher from permissible limit, same as for color.

Table.4 Physiochemical analysis of filtered drinking water

S.no	Parameters	Unit	Mehran campus secondary school	Sindh campus secondary school	WHO Permissible range	US-EPA Permissible range
1	pH	-	8.28	8.30	6.5-8.5	6.5-8.5
2	Turbidity	NTU	10.7	9.0	5	4
3	DO	Parts per million (ppm)	0.001	0.007	5.005	1
4	Color	Pt-Co	58	68	15	Unobjectionable
5	EC	S/m	1590	1379	1660	1055
6	TDS	Milligrams per liter (mg/l)	760	810	1000	500
7	Salinity	g/kg	0.6	0.9	0.6	1.0

2.3.3 Microbial analysis

The collected water sample was used to analyze the bacterial contamination. The Eosin Methylene Blue (EMB) agar used particularly for staining of Gram-negative bacteria. EMB contains dyes that are toxic to Gram-positive bacteria. Fig3 describe the overall procedure where sample was passed through 0.45 micrometer filter paper so the bacteria are left on it and then placed this filter paper on EMB agar for 24 hours for incubation at 37°C to check the growth of different harmful bacteria which are found in drinking water.



(a) Eosin Methylene Blue (EMB) agar in (b) petri plates in (c) sample 1A (Mehreen school) and 2A (Sindh school) with its (d) 24 hour growth on filter paper

Figure.3 Laboratorial analysis of drinking water sample

3. RESULTS AND DISCUSSION

3. 1 Toilet Facilities

Improved toilet facilities are one of prerequisite and fundamental right of children in school settings. Washing hands specially after attending toilet is compulsory for personal hygiene. As far as the situation regarding handwashing facilities is concerned, it is improved in Mehran School as compare to Sindh Schooll as proved through the conducted response. Fig4.a the average response of boys as “yes” against toilet facilities at Mehran School is 29 whereas response of the same in Sindh School is 20.8 in Fig4. b. The average response of boys in “no” against toilet facilities at Mehran School Jamshoro is 58.2 whereas response of the same in Sindh School is 60.6. The average response of girls in “yes” against toilet facilities at Mehran School Jamshoro is 14.6 whereas response of the same in Sindh School is 12.6. The average response of girls in “no” against toilet facilities at Mehran School Jamshoro is 69 whereas response of the same in Sindh School is 66.4.

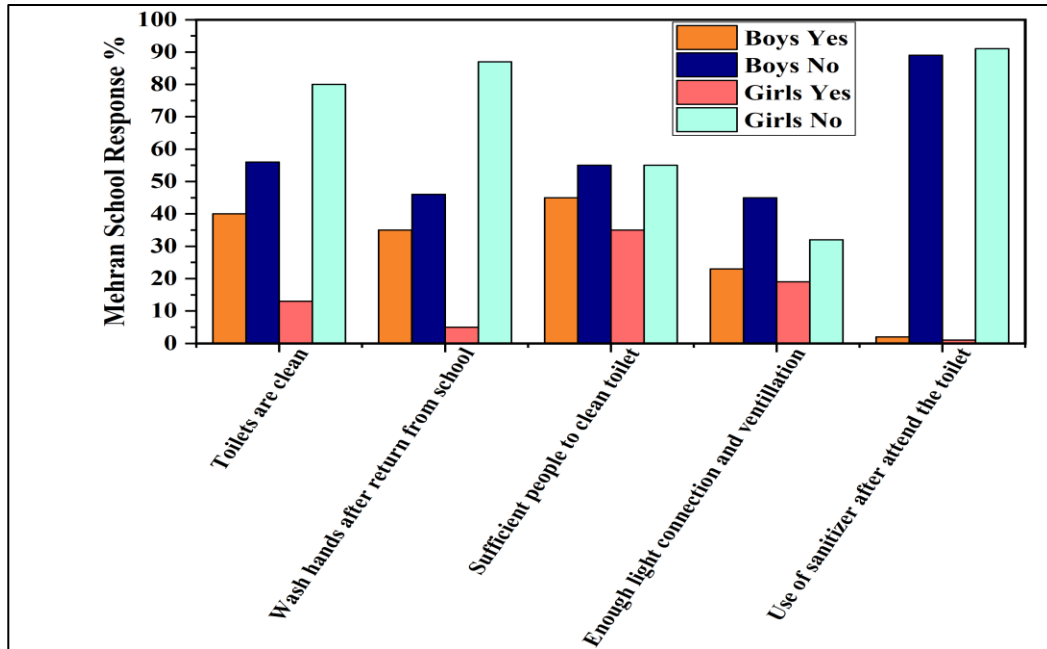


Fig.4a showing Mehran school toilet facilities

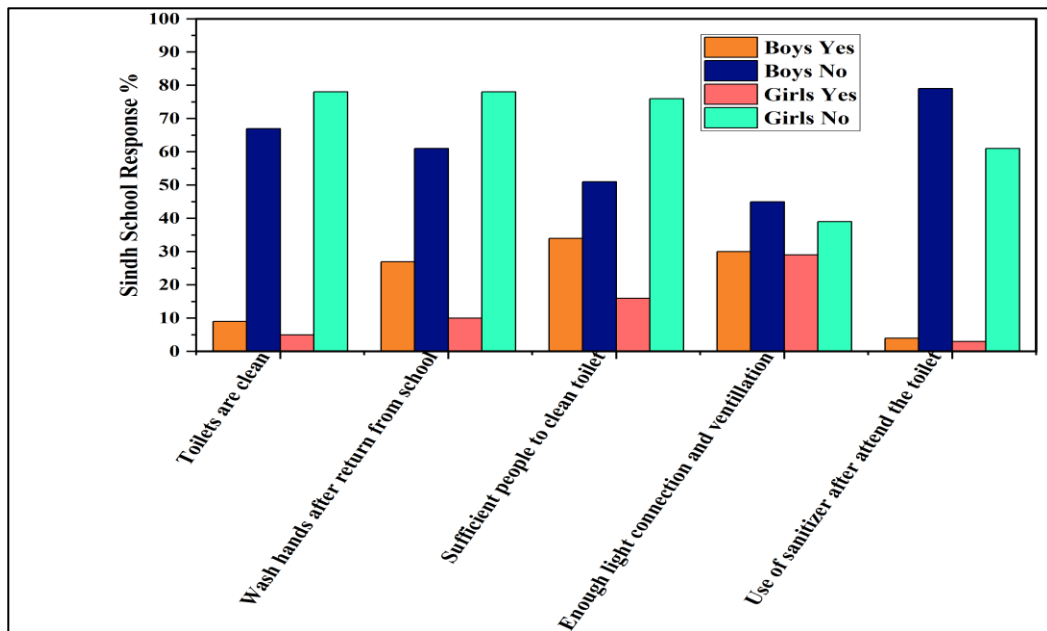


Fig 4b Sindh School toilet facilities.

3.2 Handwashing Facilities

Hand-washing with soap has proved to be an effective preventive measure to fight against the infectious diseases, respiratory infections and gastrointestinal diseases. Poor access to water, sanitation, and handwashing (WASH) facilities has found to be the biggest reason behind stunting and wasting in children. When hand washing facilities are analyzed then following statistical data is acquired in order

to compare the condition of both schools. Fig5a and 5b explain the average % response of boys in “yes” against hand washing facilities at Mehran School Jamshoro is 11 whereas response of the same in Sindh School is 17.4. The average response of boys in “no” against hand washing facilities at Mehran School Jamshoro is 82.5 whereas response of the same in Sindh School is 80.8. The average response of girls in “yes” against hand washing facilities at Mehran School Jamshoro is 15.8 whereas response of the same in Sindh School is 20.3. The average response of girls in “no” against hand washing facilities at Mehran School Jamshoro is 74.8 whereas response of the same in Sindh School is 82.68.

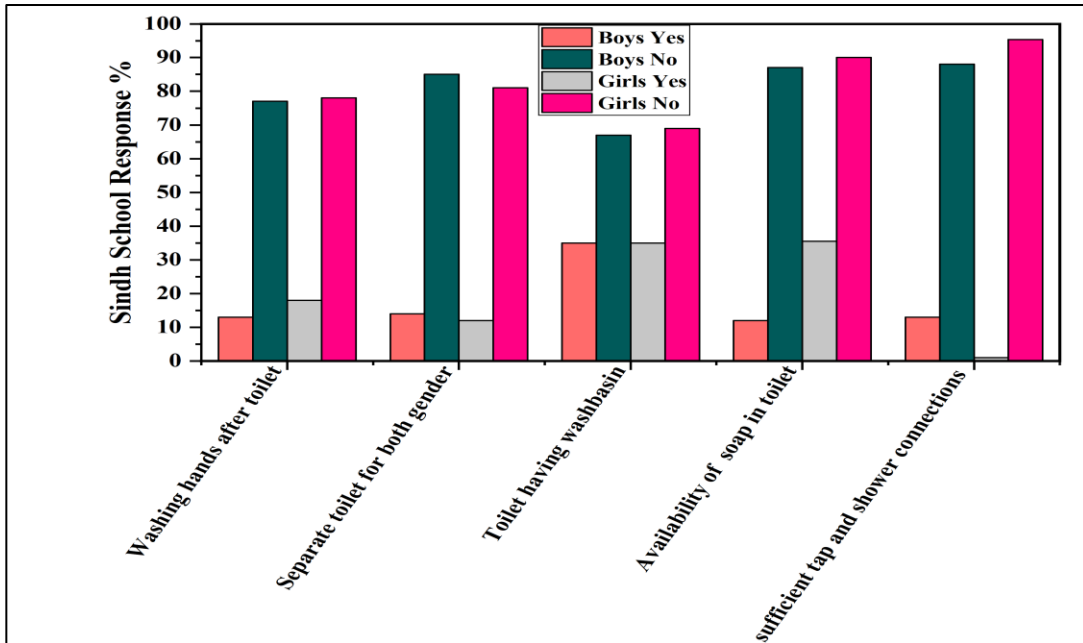


Fig.5a showing Mehran school handwashing facilities

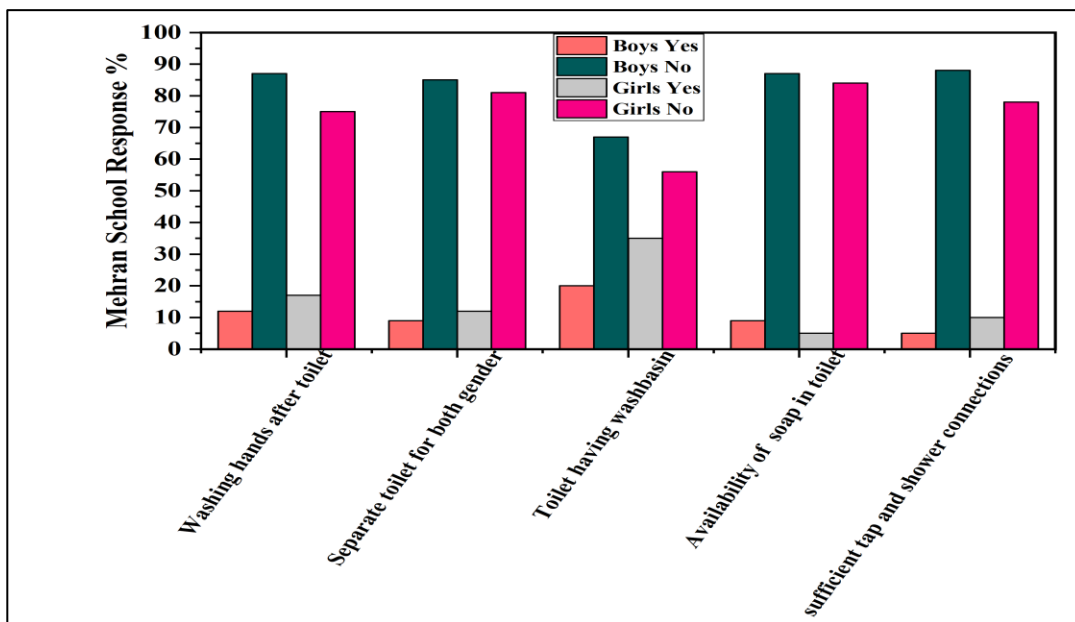


Fig 5 (b) Sindh School handwashing facilities.

3.3 Drinking Water Facilities

Drinking water quality affects directly human health. Assessment of water quality is crucial for prevention of water-borne diseases, especially for children. Fig.6.a and 6.b shows the average response of boys in “yes” against drinking water facilities at Mehran School Jamshoro is 33.6 whereas response of the same in Sindh School is 22.6. The average % response of boys in “no” against drinking water facilities at Mehran School Jamshoro is 52.2 whereas response of the same in Sindh School is 62.8. The average response of girls in “yes” against drinking water facilities at Mehran School Jamshoro is 21.4 whereas response of the same in Sindh School is 24.6. The average response of girls in “no” against drinking water facilities at Mehran School Jamshoro is 63.6 whereas response of the same in Sindh School is 59.2.

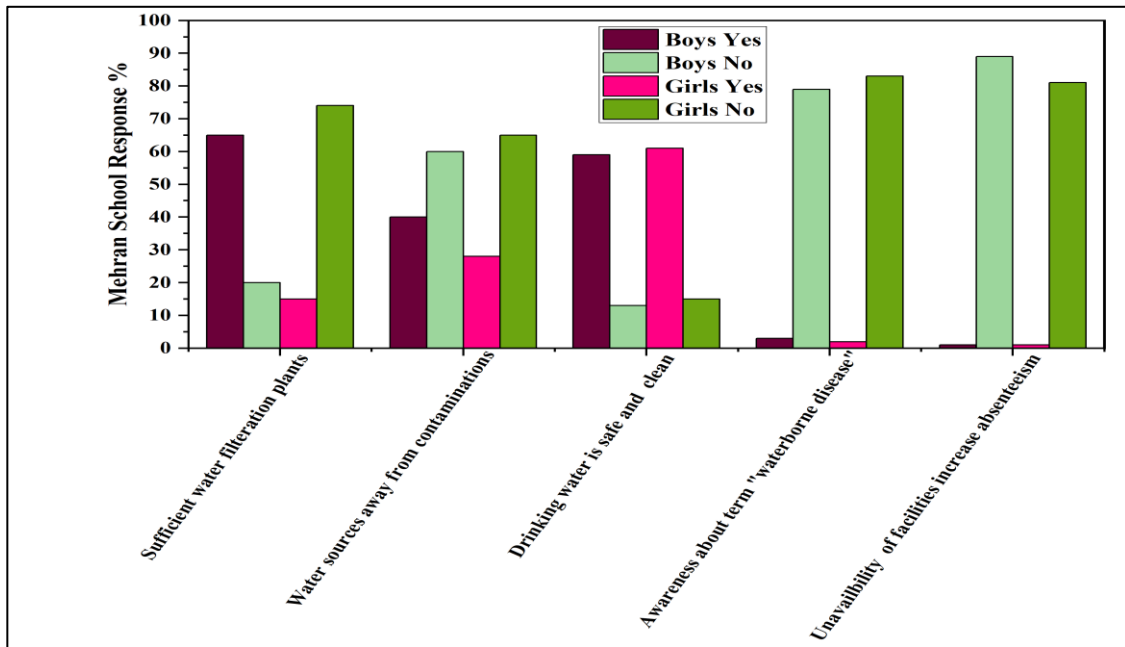


Fig.6a showing Mehran school drinking water facilities

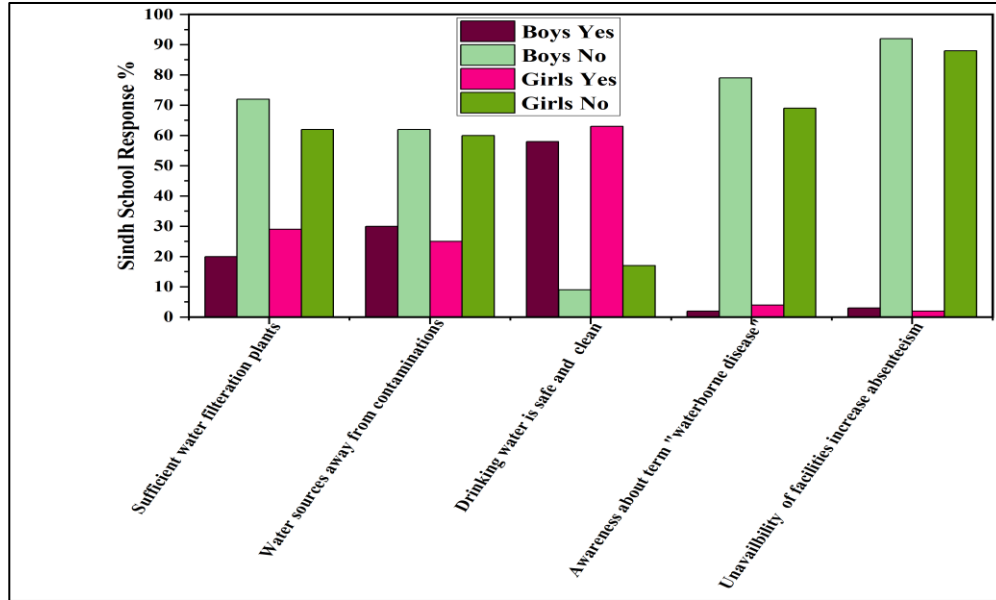


Fig 6.b Sindh School drinking water facilities.

3.4 Hygiene Practices

Poor hygiene practice is a major health concern mainly in developing countries where resources are less to cater the needs of huge population and is a leading factor behind absenteeism of school going children. Fig7.a and 7.b shows the average % response of boys in “yes” against Hygiene practice at Mehran School Jamshoro is 20.6 whereas response of the same in Sindh School is 20.4. The average response of boys in “no” against Hygiene practice at Mehran School Jamshoro is 59.6 whereas response of the same in Sindh School is 54.5. The average response of girls in “yes” against Hygiene practice at Mehran School Jamshoro is 25.8 whereas response of the same in Sindh School is 29.6. The average response of girls in “no” against Hygiene practice at Mehran School Jamshoro is 52.8 whereas response of the same in Sindh School is 52.2.

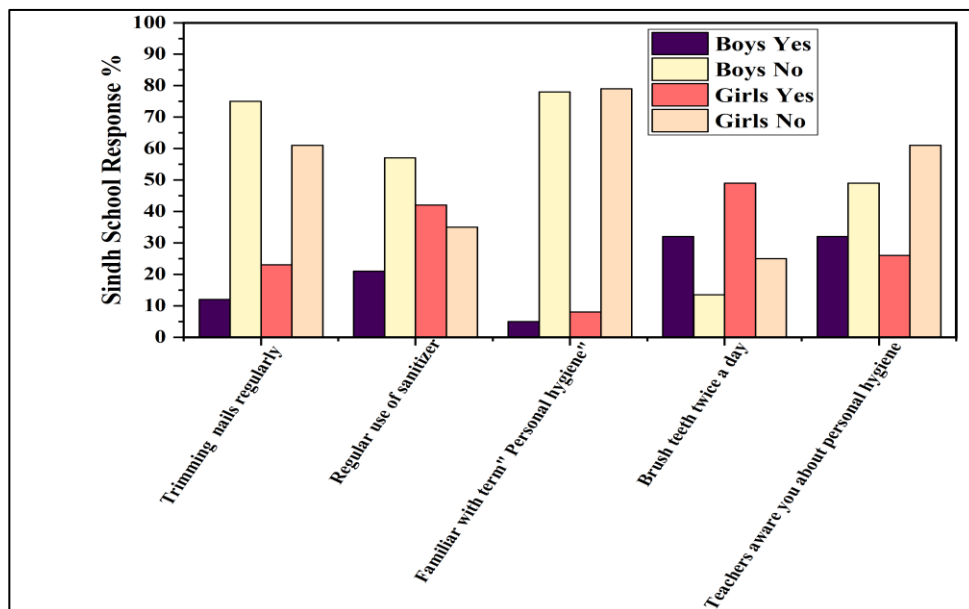


Fig.7a showing Mehran school personal hygiene

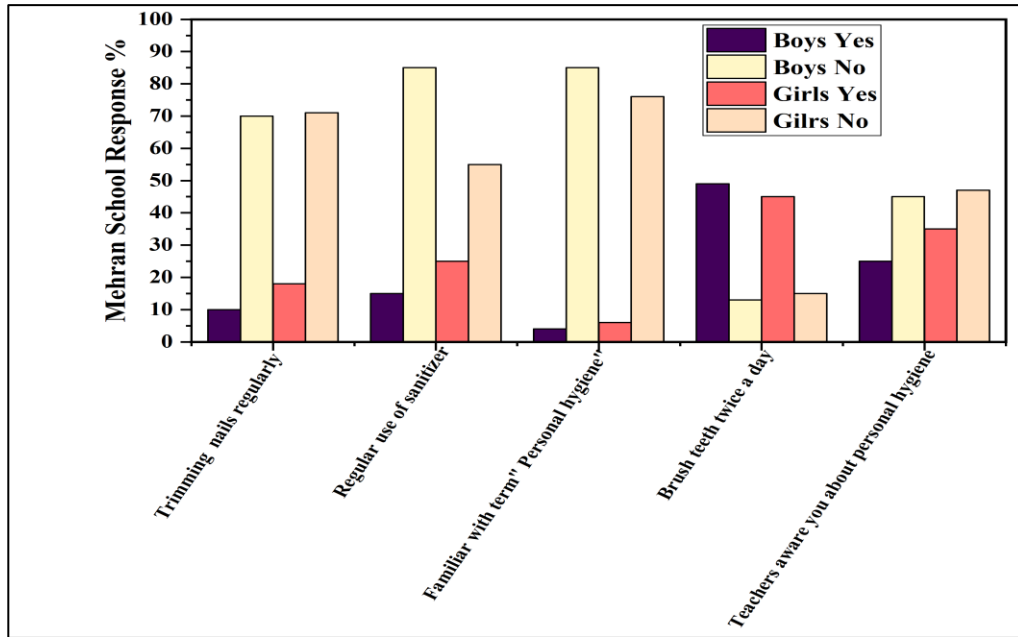


Fig 7.b Sindh School personal hygiene facilities

3.5 Fluorescence Microscope Analysis

The grown sample of bacteria was checked through the *Fluorescence microscope*. Table 5 shows the observed characteristics and morphology which matches with details provided in Benson's Microbiological Applications, Laboratory Manual in General Microbiology 2016. Fig 8 shows the fluorescence microscopic image of bacterial species in Mehran School. Same as for Sindh school in Fig 9.

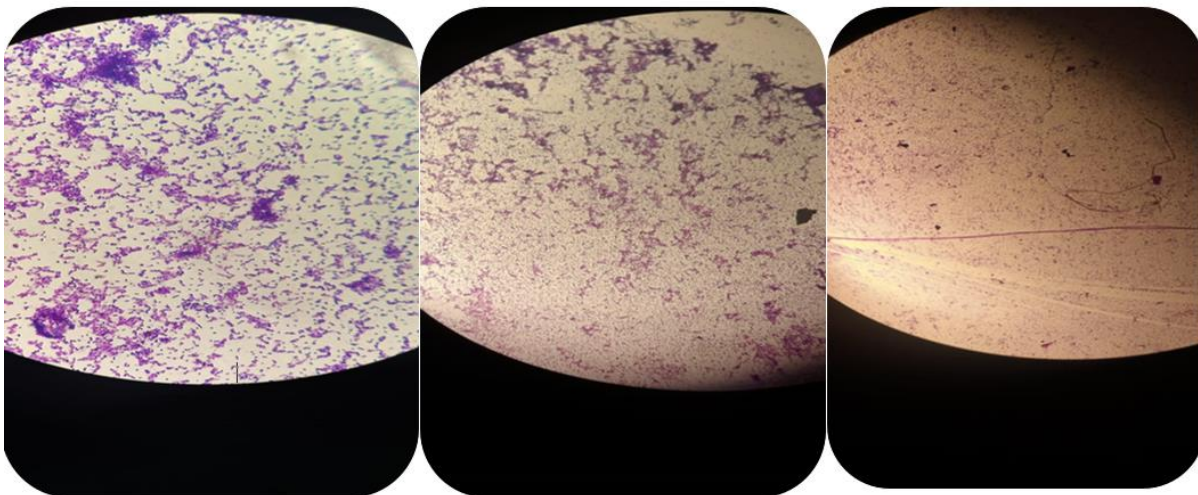


Figure. 8 Sample 1A: Mehran school drinking water contains bacterial species

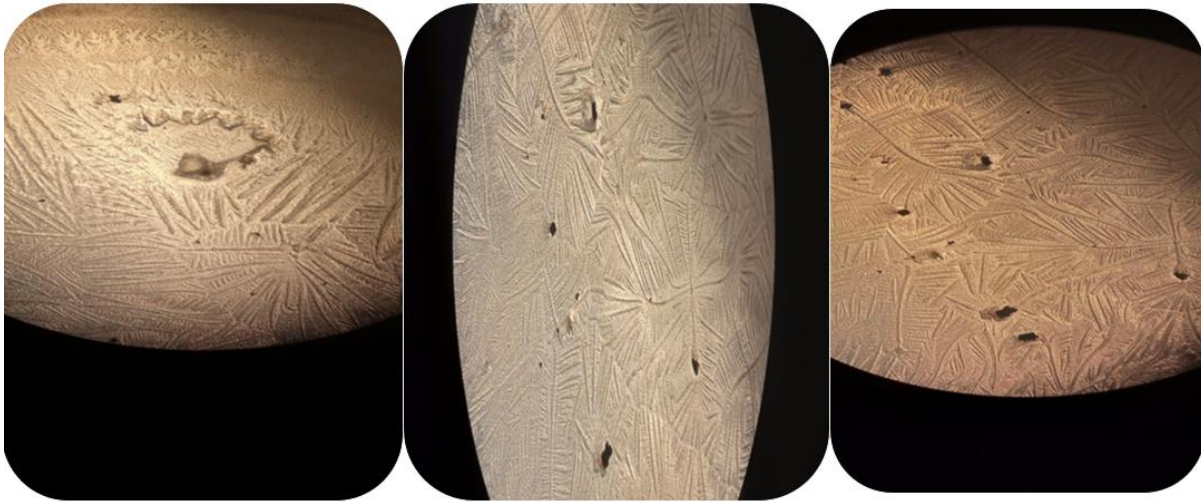


Figure. 9 Sample 2A: Sindh school drinking water contain bacterial species

4. Conclusion

Public health is a tool to gauge the progress of the any country. This study provided a comprehensive overview of the existing WASH facilities in primary school settings and its impact on children learning and behaviors. Findings from this study describes the precarious situation of WASH facilities through survey and lack of national WASH policy in educational institutes. Clean water, improved sanitation and hygiene, and a healthy environment is everyone’s innate right. Sindh has hundreds of primary and secondary schools, one of the leading causes of absenteeism is poor health due to unimproved water and malnutrition. Children are vulnerable from acute to chronic diseases like flu, fever, diarrhea, malaria, dengue, teeth & bone problems, and several gastrointestinal issues.

5. Recommendations

There is dire need of prevalence of good WASH practices among school children. It will make them imbibe the culture of cleanliness and safety to curb the diseases. Therefore, government and school’s authorities ensure to provide a healthy environment to all schoolchildren. In addition to this they also guarantee the implementation of SDGs related to wash in school settings. There are some recommendations as:

- a) To determine the most vulnerable group among population who particularly affected in the absence of WASH policy and framework.
- b) To formulate a comprehensive document which will be used as a tool to address the water-related issues and diseases that are endemic in Pakistan; more specifically in Sindh’s schools.
- c) Carefully assess the root causes of malnutrition in children under five years to suggest the cure and preventions accordingly.
- d) Recommended policy framework could be a used as milestone to improve WASH conditions and to develop a partnership between stakeholders at different levels to bring and maintain integrity and sustainability.
 - a) Water pricing is one of the economic instruments for the provision of safe water to ensure equity and equality.
 - b) To promote WASH, make it an integral part of the curriculum at least at the primary level.

- c) A special inspection committee is suggested to formulate from national to local levels to inspect the WASH facilities.
- d) Constitution of a team in the supervision of health ministry is suggested to make which will work on policy framework particularly and make amendments when needed.
- e) Rules and regulations of WASA, WAPDA, and other organizations are needed to revise.
- f) Technical expertise is needed to be fully utilized for the sake of water treatment at a sustainable level especially in remote areas where potable water is only a dream now.
- g) To ensure WASH for all, a vertical integration and feedback loop is suggested to promote the health facilities and to curb water-related diseases.
- h) The state is suggested to grant a special percentage in the budget to ensure WASH facilities and its expansion to make it more advanced with the time.
- i) There is a soft suggestion to use social media, billboards, etc. especially dedicated to WASH awareness to normalize the importance and inclusion of WASH in daily life.

Acknowledgements

We are immensely grateful for such cooperation by School administration and students collaborated so well to conduct this study. Lastly, US-Pakistan Center for Advance Studies in Water, Mehran University of Engineering and Technology for providing platform to accomplish this research data analysis.

Statements & Declarations

In advance a permission letter from the HOD of WASH department Jamil Ahmed, USPCASW department was acquire for data collection. Permission in advance was taken from all the participants by elucidate the purpose, nature, and procedures used in the study. Likewise, participants were allowed to with- draw their names from the study at any time without explaining the reason for it. The respondents were also informed that payment of any form would not be provided for taking part in the study.

Competing interests, the authors declare no competing interests

Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Consent to Participate the respondents were cleared that their participation in the study was just voluntary and their names or their school address will not be recorded.

Ethical Approval. Confidentiality was ensured throughout the study period such as; during data collection, data analysis, and result declaration.

Funding This research is conducted with the help of United States Agency for International Development (USAID) funding for providing financial support through USPCASW.

kinz Using Brown Seaweed Iron Oxide Modified Biochar

Innovative way of Detecting and Analysis of Foodborne Pathogens via Smart Devices

Sugaina Oad*, Maryam Arain, Neha Jewraj, Sana Jamali, Manisha Lohana⁴²

Abstract

Foodborne disease, also called foodborne illness is any sickness that is caused by the consumption of foods or beverages that are contaminated with certain infectious or noninfectious agents. We have focused on sustainable Goals 2: Zero Hunger, Goal 3: Good Health and Well-being, and Goal 8: Decent Work and Economic Growth which target food security, that is the access to sufficient, safe, and nutritious food meeting needs for an active and healthy life, as on-site early detection of disease-causing bacteria before the consumption can lead to a nutritious and healthy life with no disease and economy stability from not spending a bunch of amount on health issue occurring from contaminated food ingestion. Early pathogen detection can determine the specific pathogenic bacteria present in the food sample, enabling the appropriate steps to be taken to prevent the food from spoiling and ensure that it is safe for consumption. Otherwise, consuming infected food and disposing of it will cause health and environmental issues, such as groundwater and surface water pollution from biohazardous waste disposed on land or/and dumped in water bodies. Our targeted pathogens are Salmonella typhi and Staphylococcus aureus, which are two of the top five foodborne pathogenic bacteria. To identify these pathogenic bacteria, present in a food sample, datasets were prepared of each bacteria. The images for the datasets were captured with a smartphone camera through a portable optical microscopic device that we designed and created. The device is easy to use, compact, and portable and can transform any smartphone into a High-Resolution Microscope. These datasets are then manipulated or enhanced with image processing so that bacteria can be accurately identified. Further, a machine learning model is developed which is trained, tested, and evaluated by the augmented datasets. The algorithm of the model learns from the images in the dataset and provides an outcome based on the dataset. A Tensor Flow lite model is then created in the teachable machine website which is then exported into the android studio for application development. Finally, a smartphone app that is user-friendly and can identify accurate foodborne pathogens has been developed on the Android operating system.

Keywords – Foodborne, pathogens, smartphones, portable microscope, machine learning.

I. Introduction

Foodborne disease, also called foodborne illness is any sickness that is caused by the consumption of foods or beverages that are contaminated with certain infectious or noninfectious agents [1]. Foodborne pathogens can be any viruses, bacteria, or parasites, they are biological agents that can cause a foodborne sickness or disease. A foodborne disease outbreak is defined as the occurrence of multiple cases of a similar condition resulting from the ingestion of shared food. Foodborne illness occurs when a pathogen is ingested with food and establishes itself (and usually multiplies) in the human host, or when toxigenic pathogens establish themselves in a food product and produce a toxin, which is then ingested by the human host. Hence, foodborne sickness or illness is typically classified into two

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categories, first one is foodborne infection and the second one is foodborne intoxication. Bacteria are the most common cause of foodborne diseases and exist in a variety of shapes, types, and properties. Bacterial foodborne infections occur when food contaminated with bacteria, is consumed and the bacteria continue to grow in the intestines, causing an infection that leads to illness. Some common foodborne bacteria are Salmonella typhi, Clostridium perfringens, Campylobacter, and Staphylococcus aureus (Staph). The targeted bacteria of this study are salmonella and Staphylococcus aureus which are included in the list by CDC of the top five germs causing illness from consuming food. Salmonella, Campylobacter, hemorrhagic E. coli, and Listeria all cause infections. Food intoxication results from the consumption of toxins (or poisons) produced in food by bacterial growth. Toxins, not bacteria, cause illness. Toxins do not always change the appearance, odour, or taste of food which humans can detect by their five senses, especially in the beginning also known as the incubation period. Bacteria that commonly produce toxins are Staphylococcus aureus and Clostridium botulinum. In foodborne infections an incubation period is usually involved, where the time from ingestion until any symptoms appear is much longer than that of foodborne intoxications. Researchers have identified more than 250 foodborne diseases [2]. Hence, it is important to detect the presence of pathogens in food rapidly before it enters the body to cause a serious outbreak. Severe consequences of foodborne diseases include kidney and liver failure, brain and neural disorders, reactive arthritis, cancer, and death. CDC (Centers for Disease Control and Prevention) estimates that each year 48 million people get sick from a foodborne illness, 128,000 are hospitalized, and 3,000 die [3]. Foodborne pathogens can be found in various foods and it is important to detect foodborne pathogens to provide a safe food supply and to prevent foodborne diseases.

Symptoms, the onset of symptoms, and responsible microorganisms or toxins of targeted foodborne illnesses are shown in the following table 1:

Table 1 Associated organism or toxin, its symptoms, and approximate time to symptoms

Estimated time when symptoms start	Causes	Related organism and/or toxin
1–7h, Mean 2–4h	Nausea, vomiting, retching, diarrhea, abdominal pain, prostration, staphylococcus scalded skin syndrome, and cellulitis.	Staphylococcus aureus and its enterotoxins.
6–96h (Usually 1–3 days)	Fever, abdominal cramps, diarrhea, vomiting, headache	Salmonella spp., Shigella spp., E. Coli.
1–4 weeks	Malaise, headache, fever, cough, nausea, vomiting, constipation, abdominal pain, chills, rose spots, bloody stools	Salmonella Typhi.

MORPHOLOGY OF TARGETED PATHOGENS

Salmonella:

It is Gram-negative which means it appears red in color.

Shape: Rod-shaped enterobacterium.

Size: Ranges from 0.7–1.5 μm to 2.2–5.0 μm .

Colonies Size: Salmonella produces colonies of approximately 2–4 mm in diameter.

They can be sometimes nonmotile but they contain peritrichous flagella.

Staphylococcus Aureus:

It is Gram-positive bacteria which means it appears blue in colour.

Shape: Spherical shape.

Arrangements: They are often in clusters resembling a bunch of grapes and the diameter of its cells ranges from 0.5 to 1.0 μm .

It is of the utmost importance to examine food samples for the existence of pathogenic bacteria to ensure consumer health and reduce the incidence of these Foodborne illnesses. For this, one of the important techniques is the early detection of pathogens in food. Image processing is one such tool that is used for early and rapid detection.

Image Processing means processing or manipulating digital images utilizing a digital computer. We can also say that it is a use of computer algorithms, to get enhanced images to extract some useful information [4]. Generally, there are two types of image processing: Digital image processing and Analog image processing. Digital image processing is a technique that is used to help in manipulation of the advanced pictures by utilizing computers. Whereas Analog image processing is used for hard copies such as photographs and printouts, we have used digital image processing. Digital image processing requires: importing the image via image acquisition tools, Analyzing and manipulating the image, and the output in which the result can be altered image or report that is based on image analysis.

Traditional microbial detection methods such as plating are time-consuming and laborious. Because of this, more research has been conducted to develop technologies that can detect and identify pathogens in foods in a relatively short period compared to conventional methods [5]. Conventional methods are usually inexpensive and simple, but these methods can be time-consuming as they depend on the ability of the microorganisms to grow in different culture media. Usually, conventional methods require 2 to 3 days for preliminary identification and more than a week for confirmation of the species of the pathogens [6]. Recently, different rapid methods with high sensitivity and specificity have been developed to overcome the limitations of conventional methods for the detection and identification of foodborne pathogens. Recent techniques for detecting microorganisms in foods such as microscopy and image analysis have drastically reduced the time required to detect microorganisms in foods.

The proposed work is done to identify the different bacterial pathogens present in a food sample. For identification, datasets of Salmonella and Staphylococcus aureus is prepared, both of these are foodborne pathogenic bacteria. The images for the datasets were captured with a smartphone's camera through a portable optical microscopic device, that was also designed and created especially for bacterial detection; this device is easy to use, compact and portable and can transform any smartphone into a high-resolution microscope. These datasets are then augmented with image processing so that bacteria in a food sample can be accurately identified. Further, a machine learning model is developed which is

trained, tested, and evaluated by the enhanced dataset. The algorithm of the model learns from the examples contained in the dataset and provides an outcome based on the dataset. Finally, a smartphone app that is user-friendly and can identify targeted foodborne pathogens accurately has been developed.

II. METHODOLOGY

A. Design of The Portable Microscope

The purpose of the device is to capture microscopic images of Foodborne bacteria that cause disease. The device is easy to use, compact, and portable and can transform any smartphone into a high-resolution microscope [7]. The device has four main components: stage, slide, lens, and smartphone which are described following:

1) **Stage:** The stage is a supporting system of the objective lens, slide, light source, battery holder, and on-off switch. It also has a mechanical system that allows fine movement of the prepared slide into two perpendicular directions so that the specimen can be thoroughly searched for targeted microbes. The mechanical system is controlled manually with gears by the user, manual searching of the specimen is the fastest way to find the region of interest of the specimen to observe with the powerful objective lens of 150x magnification. The light source is placed below the first layer of the stage, providing bright and uniform illumination in the region of the specimen under observation. The whole device is designed in a way that it can be easily handled by nonprofessional users, hence it is user-friendly.

9. Component of Stage

10. The stage's components are shown below in figure 1, figure 2, figure 3, and figure 4:



11. Fig 1. Stage

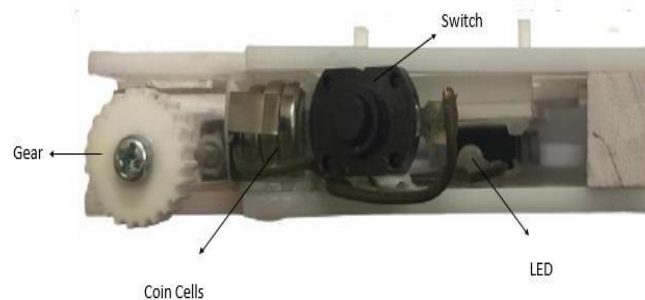


Fig 2. Inside the Stage

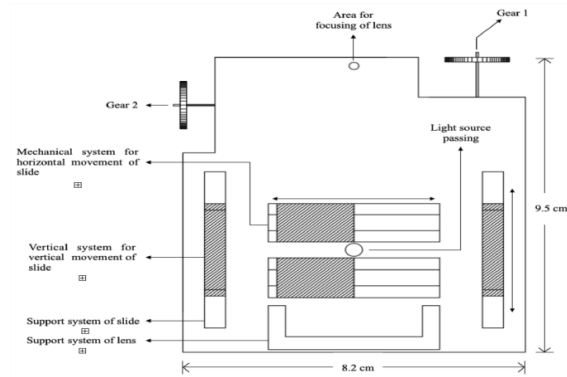


Fig 3. AutoCAD Design of Top View of Smartphone-Based Portable Microscope's Stage.

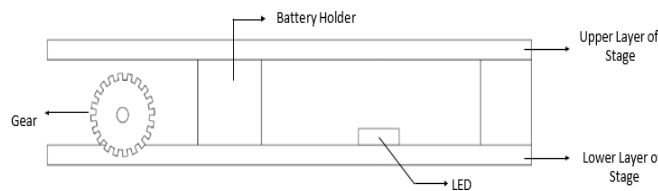


Fig 4. AutoCAD Design of Size View of Smartphone-Based Portable Microscope's Stage.

- Support System of Slide: It is a rectangular area on the stage where a prepared slide is fitted for observation.
- Support System of Objective Lens: It is a C-shaped area on the stage where the objective lens is fitted.
- Mechanical System: It allows the movement of the slide in two perpendicular directions (x and y) so that the interested or specific area of the specimen can be observed accurately.
- Gear: Gear 1 is used for the vertical movement of the slide whereas gear 2 is used for the horizontal movement of the slide.
- Illumination Source: A LED is used as a source of visible light for specimen detection.
- Battery holder, Batteries, and On-Off Switch: A battery holder and an on-off switch of LED are also built inside the stage. Three LR1 130 micro alkaline cells in a battery holder with 1.5 volts are used which is connected with an On-Off switch.

2) **Prepared Slide:** A prepared slide refers to a slide that has been previously mounted with a specimen that is ready for observation.

12. Preparation of slide: Multiple slides of each targeted bacteria i.e. Salmonella and Staphylococcus aureus were prepared through the Gram Staining technique as shown in figure 5 from pure cultures as shown in figure 6.

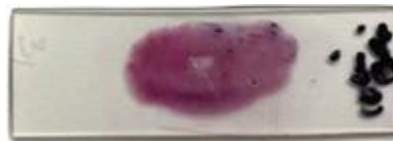


Fig 5. Prepared Slide



Fig 6. Culture of Staphylococcus Aureus and Salmonella

- 3) **Magnifier and Focusing screw:** A separable objective lens of magnification is placed with the camera lens of the smartphone. Having the objective lens separate from the lens of a smartphone camera means that it does not depend on the shape or size of a phone. The lens provides 150x magnifications with a resolution of 0,7/0,8 micron and its working distance is 0.3 mm. The above values are further multiplied by the digital zoom of a smartphone's camera, allowing for magnification of more than 1000x and the ability to see details of less than 1 micron (1/1000 mm) in size. Whereas a focusing screw is used as a fine focus knob; it sharpens the focus quality of the image. The focusing screw sets the ideal focus so the image is visualized clearly.



13. Fig 7. Focusing screw

14.

- 4) **Smartphone:** The images of microbes from the specimen on the prepared slide are captured by the camera of a smartphone attached to the objective lens.

Device with All Its Attachments

Following figure 8 shows a fully functioning smartphonebased portable microscope

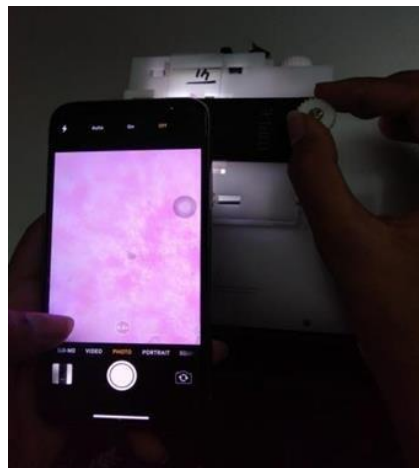


Fig 8. Device with all its attachments

B. Working of the smartphone-based portable microscope

To capture an image of bacteria and save it for later identification or to identify bacteria on the spot for early detection, following are the steps on how to use the smartphone-based portable microscope.

- i. Turn on the Light by clicking on the button fitted on the side of the stage.
- ii. Place the sample slide in its place and set it in the center of the illuminator hole.
- iii. Fix the Objective Lens on the slide and insert the focusing screw through a small focusing hole on the lens's metallic plate.
- iv. Set the mobile phone on the lens, through a camera app move and position the phone camera on the lens.
- v. Using Slide Movers search for the area on the slide that is required for the detection and focus by focusing screw to get a sharp image.

C. Development of Dataset

Datasets of salmonella and staphylococcus aureus are developed by taking pictures of prepared bacterial slides from the smartphone-based portable microscope via a smartphone.

Images of both bacteria are captured in huge quantities for the development of datasets so that the machine-learning model can give accurate results. These datasets were then augmented by online software to further increase quantity and quality. Complete datasets of Salmonella and Staphylococcus Aureus each consisting of more than 3000 augmented images are developed.

Dataset of Salmonella Typhi:



Fig 9. Microscopic image of Salmonella typhi on slide

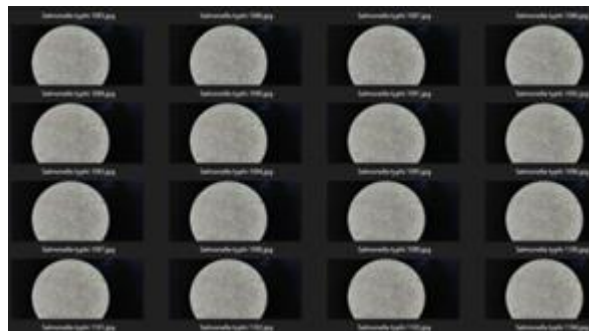


Fig 10. Zoomed picture of Dataset of Salmonella Typhi



Fig 11. Dataset of salmonella typhi contain 3200 augmented image

Dataset of Staphylococcus Aureus:

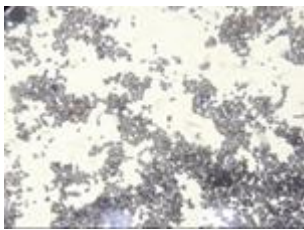


Fig 12. Microscopic Staphylococcus Aureus

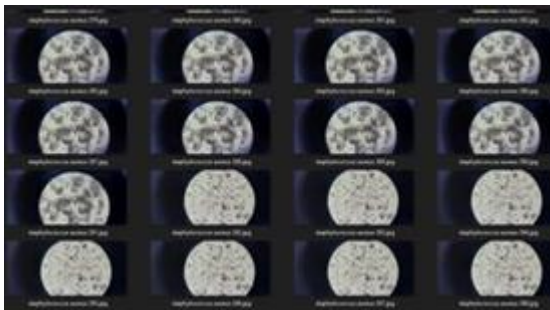


Fig 13. Zoomed picture of Dataset of staphylococcus aureus



Fig 14. Dataset of staphylococcus aureus containing 3200 augmented images

D. Development of Machine Learning Model

A python model was developed to test that the pictures captured were enough for the accurate detection of foodborne pathogens. This python model was Convolutional Neural Network based and was trained

and tested by the captured datasets of Salmonella and Staphylococcus aureus. This model is for a desktop-based application and was developed basically for testing of captured datasets.

E. Development of Android Application

Developed a machine learning model for android based smartphone application by using Teachable Machine. In the teachable machine, datasets were uploaded and the model was trained. Trained model provides output. This output is exported to TensorFlow lite (TFL). A TFL model is generated which is then downloaded. Then the TFL model is imported into android studio and android based smartphone application is developed. The application is developed containing four activities: splash screen, user guide step 1, user guide step 2, and interface. After interface application shows results.

F. Working of Foodborne Bacterial Detection Application

1. Download and open application named FBBD (foodborne bacterial detection) on android smartphone.



Fig 15. Icon of Application

2. As application opens, splash screen will appear first. Wait for 5 second.
3. After 5 seconds, Screen with step 01 will appear, follow the instructions given in the application for the preparation of slide by gram staining, then click ok. As shown in figure 16.

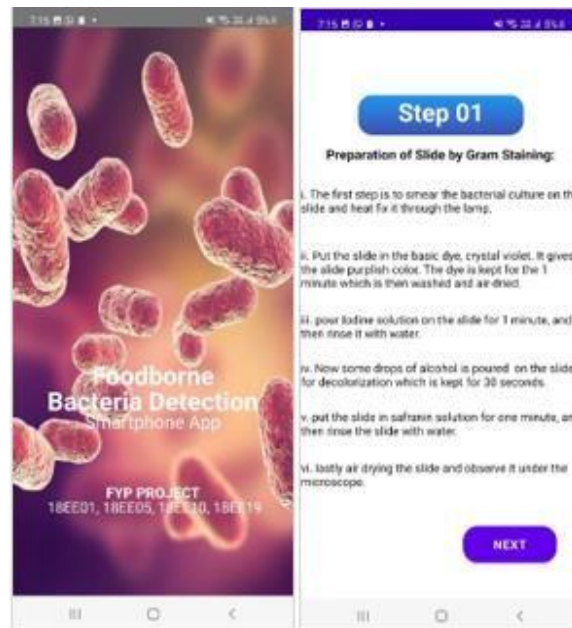


Fig 16. Splash Screen and User guidance screen for slide preparation.

- 4. Read the instruction in step 02 screen, these instruction guides the user how to capture or select image that model can classify image accurately, then click ok.
- 5. 4th screen will appear, choose the option through which you want to classify the image i.e. scan image using camera or choose image from gallery, then click ok. As shown in Figure 17

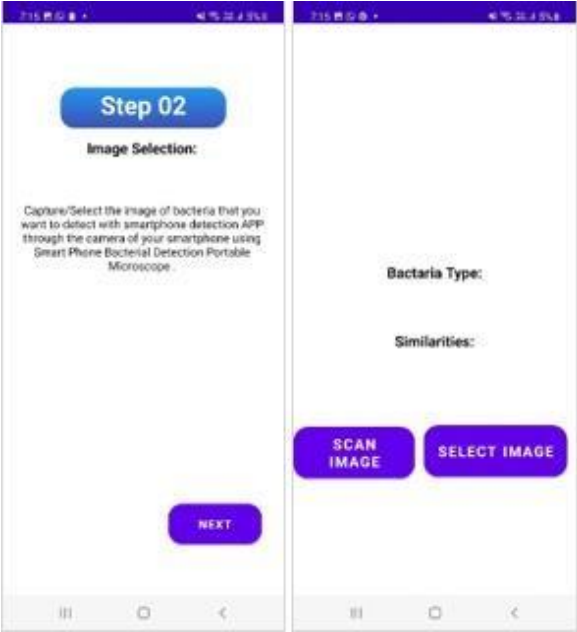


Fig 17. User guidance screen for image identification and capturing image via camera or selecting image from gallery

- 6. The application then will show the results. As shown in Figure 18.



Fig 18. Screen showing results after image input

III. RESULTS

As we have worked on two models, first one is based on CNN in python language in google colab. It was developed for training and testing of dataset and second one is developed from teachable machine as TFL model for application development in android studio.

Results from Testing and Training of Dataset:

Training Results: The execution time is the overall amount of time needed for computations, such as data splitting, data preparation, and model evaluation. Training time is the amount of time needed for a model to train on a dataset. Trained Model provides 100% accuracy as shown in.

Testing Time: When an algorithm applies a learnt model to create predictions, this is referred to as the test time. The period during which an algorithm learns a model from training data is referred to as training time. The model's training time is depicted in the image below in figure 19. Tested model provides 42% Accuracy.

```
#evaluating model
train_loss, train_acc = model.evaluate_generator(train_dataset, steps=10)
test_loss, test_acc = model.evaluate_generator(validation_dataset, steps=10)
print("Train Accuracy: ", train_acc)
print("Test Accuracy: ", test_acc)

/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:2: UserWarning: "Model.evaluate_generator" is deprecated and will be removed in a future version. Please use "Model.evaluate" instead.
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:3: UserWarning: "Model.evaluate_generator" is deprecated and will be removed in a future version. Please use "Model.evaluate" instead. This is separate from the Ipykernel package so we can avoid doing imports until.
Train Accuracy= 1.0
Test Accuracy= 0.42500001192002896
```

Fig 19. Train Accuracy and Test Accuracy of model

Results of application containing TFL model using backend java:

Analyzed multiple different samples of targeted Foodborne Pathogens I.e. Staphylococcus aureus and salmonella from smartphone-based portable Microscope and FBBP application. From results, it is interpreted that the average accuracy of Salmonella typhi is about 99% and Staphylococcus aureus is 98.72%.

Results of Staphylococcus aureus:

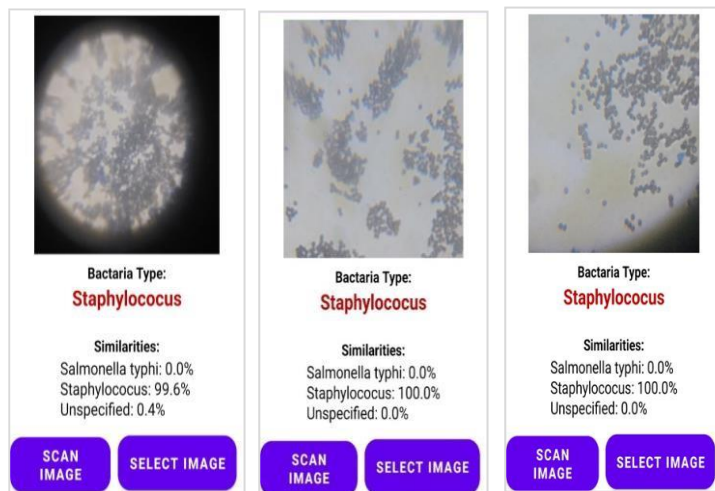


Fig 20. Results of staphylococcus aureus

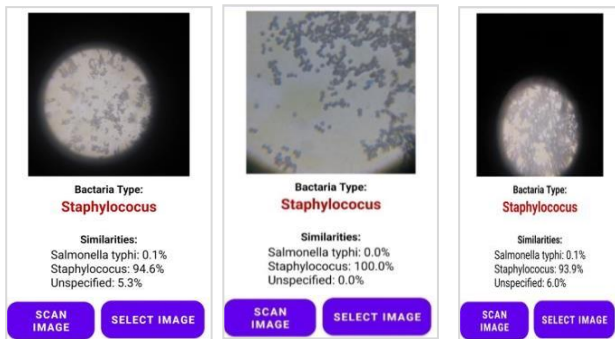


Fig 21. Results of staphylococcus aureus

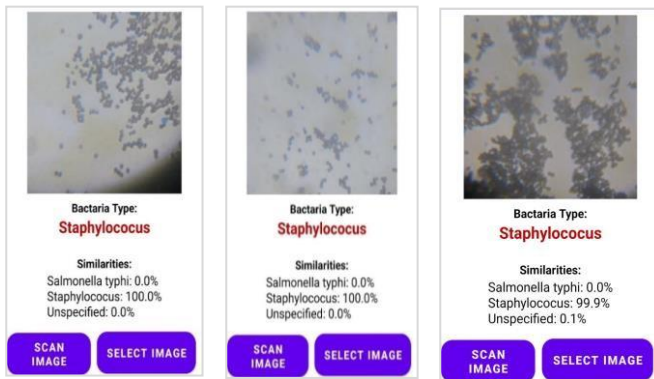


Fig 22. Results of staphylococcus aureus

Results of Salmonella Typhi:

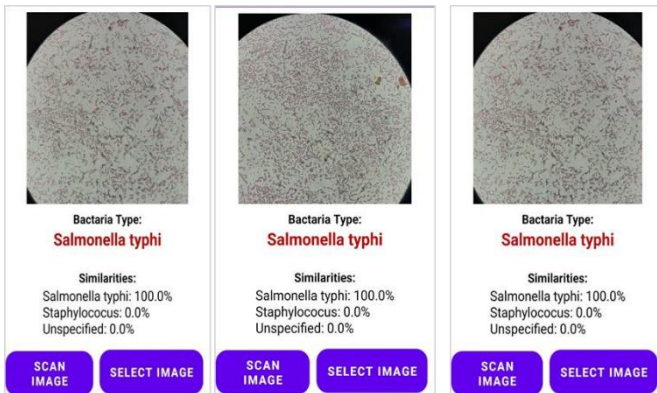


Fig 23. Results of Salmonella typhi

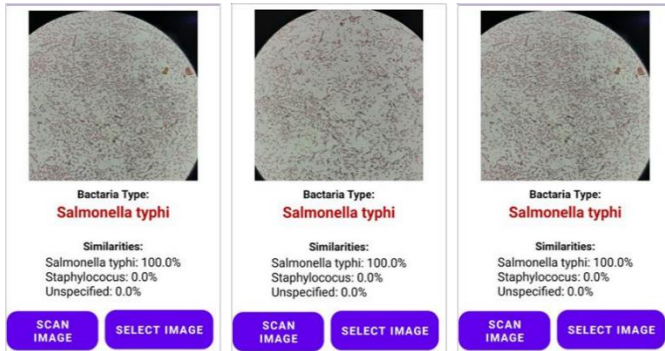


Fig 24. Results of Salmonella typhi

Unspecified: Unspecified outcome is intended to make it easier for the app to distinguish between Salmonella and staphylococcus. If we take a picture of any other bacteria the app will display decreased the percentage of accuracy in the final result.

IV. CONCLUSION

The aim of this study is foodborne pathogen detection via smartphones. The targeted pathogenic bacteria are Salmonella typhi and Staphylococcus aureus. For detection, a smartphone-based portable microscope is designed and created, this device can convert a smartphone into a functioning laboratory, and using this device augmented datasets of targeted pathogens are prepared. After this, a machine learning model and an android smartphone-based application are developed. The output of the application shows results and from these results, it is observed that the average accuracy of Salmonella typhi is about 99% and Staphylococcus aureus is 98.72%. Whereas the accuracy for the specified bacteria i.e. Salmonella Typhi and Staphylococcus is 99-100%. For the unspecified, the accuracy is 58-69%. Instant findings can be obtained with this classification system and results can be saved to a smartphone. Finally, it is concluded that bacterial classification via smart devices is much easier, saves time, requires minimal human involvement, does not need highly trained or experienced people, is cost-efficient, and is more accurate than other conventional methods.

V. RECOMMENDATIONS

In this project the work was only done on the identification of foodborne pathogenic bacteria hence waterborne pathogenic bacteria can be added. We can also mix different bacteria and make their dataset and can identify single bacteria from any food sample. Accuracy can also be increased through better micro-scoping, training, testing, and proper use of the device. The device that we have designed can be handier by set some space for mobile fixation. Our application can only be used by the android user so we can modify it for IOS users.

ACKNOWLEDGMENT

With our gratitude to the almighty god, who has granted us the capability and courage to work on this project as well as the wisdom to direct our studies in a way, that will most effectively ease humanity's burden according to their interests. We would like to express our sincere appreciation, especially to our families and friends who have supported and helped us during all phases of our life. Finally, we would like to thank the faculty members of the Institute of Environmental Engineering and Management for their guidance throughout our project work and for overseeing us in the best manner possible way.

Exploring Traditional Water Management System and Inventory Through GIS in Skardu Town (Olding Skardu)

Muhammad Ali, Dr-Ishtiaq Hussain and Dr-Salar Ali⁴³

Abstract

Water plays key role for agricultural development and other sectors including health, infrastructure, and sustainable urban development for urban and rural population. Skardu is a capital city of Baltistan Region and lies in dry temperate zone. The area has different types of landscape and biodiversity. With the increasing in population the migration and tourism also putting lot pressure on water resources, where mostly the water resources are based on glacier melting water for agriculture, water supply, electricity generation and municipal uses. The aim of this study aims to explore and mapping of local water storage for agriculture land by based on GIS and also an inventory for Olding Skardu. The people of olding and its surrounding areas uses water of sadpara dam basically the water of Sadpara Dam, however due to changing climate local town of Skardu facing water shortage in peak summer season and people of this area suffering and mentally disturbing and effects the growth rate and yield of different vegetation and crops of the area. The traditional agriculture system water level of Sadpara dam also decreases as compared to past one decade. Due to anthropogenic disturbance on upper areas of Sadparavalley and high flow of tourism during summer season causing negative effect on Sadparadam which is used for drinking purposes by the inhabitants of local community and the environment of the area including plants community and animals life. Basically the people of the community depend upon the water which comes from Sadpara dam and from the cold natural springs of Ryong Chumik through different water channels and reach to the different water storage tanks. When the climatic condition become harsh then there will be chance of floods, and it's have ability to destroy fresh water channels, farmlands, buildings, plants and many livestock's and cause of soil erosion which also losses the economy of the area and cause highly negative effects on the area of Sadpara and Olding. To decrease the soil erosion and its negative impacts, water tanks and vegetation play a vital role therefore people should minimize the cutting down of trees and do afforestation along the water channels. If we talk about the water channels and the type of water storage by the local community then they store water in different tanks by self-made and uses these water to agriculture purposes, There are many species of plants are found at the sides of these water storage tanks which act as a barrier for pollutants and also kept water cool and maintain its temperature. when water become short in summer season the local community has its own traditional rule means the water of tanks equally distributing among the local people to carry into their farmland or in agriculture filed on day based or sometimes in hour based therefore there is a balance among the people of Olding and also it's a good way to facing water shortage challenges during these critical days where the demand of water is very high. These types of rules are very helpful to save crops and vegetation from wilting and losing otherwise it will cause economic loss for the local people of community on which they highly depended. The local people are also looking for different bioengineering techniques in result it become more sustainable and helpful for them to increase the productions and yield of crops and vegetation. The area of olding town consist of 8 water storage tanks which called **rzing** in Balti language and the size of these water tanks are very among them. 3 are situated in olding pakora and 3 are situated in olding gamba grong and 2 are situated in the surrounding area of olding center. Some have size of about 50x50 some have 100x70 feet and the depth of tanks also very among them some have 7 to 8 feet and some have 10 to 12 feet. The one big water tank of the area

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is highly used by the community of the area for agriculture purposes and people are taking benefits from it but due to increase in population people are also polluting these tanks by leaving polluted water from houses and school, offices which causing negative effect on agricultural land. When the people of Sadpara and its surrounding area take their livestock's on mountainous area for grazing purpose in summer it's also a main reason of water pollution when the livestock's put their filth into the water channels and stream. Awareness through TV programs, seminar and campaign or by social media about water and soil management system are very necessary during these days so that it will be helpful for the people of this community. Implementation of traditional rules how to and at which time water channels and tanks cleaning from the dust particles and materials required and its repair strategies to the youth of this generation is one of basic requirement. We should need to take a step about manage to save water by different techniques and tools so that it will be good for community as well as agricultural purposes. There should be proper controlling for household polluted water and people should have avoided to leave their waste water directly into water channels it may cause the increase in pH level of the water tanks and reason of destructive impacts on vegetation and also losing of different microorganism species which is found at there. We should use water tanks which are safe water as well as producing access amount of vegetation and it's have positive impact on climate, controlling soil erosion and as well as risk of disaster people of the community also prefer these type of water tanks. In mountainous region glof soil management are good initiative for the community since centuries and the people of the area are resilient and hardworking. Bioengineering technique are the best technique to face the challenging of risk and disaster. Initiating a goal watershed planning and management strategies will identify priority projects and make olding communities eligible for new funding opportunities. The people should point out and highlight their problems related to water shortage with its concerns department and different other projects department and they should express their support for it to develop a regional watershed plan. If for drinking purpose water purification plants are not affordable then low cost solutions may be promoted such as plastic bottles and water storage tanks according to the weather conditions of the area.

Introduction

Mountains covered 61% of the geographical land of Pakistan are home to approximately 40 million for the people of Pakistan. Local Soil resources are play an important role in food security and economic purpose for the people of mountainous region (Zakir et al 2017). Loss of soil fertility due to water shortage has reduced food productivity, thereby increasing food misbalanced and susceptibility, of people (Hinzman L & Kane D 2000). Furthermore, climate change causing a new challenge for people living at mountains area in terms of water availability due to rising temperature. Globally, soils in mountains region are becoming significant due to environmental facilities such as carbon sequestration and watershed management. (Khalid R, 2012). The main objective of building water tanks is for agricultural commitments. Water tanks are always helpful in storing runoff water from monsoon rains, tanks support in cultivation as reservoir command area (Jayatilaka et al. 2003). Research indicates that water tanks also supply other socioeconomic uses and ecological functions (Palanisami and Meinzen-Dick 2001; Shah and Raju 2002). Water from tanks facilitates many economic (e.g., fisheries) and domestic (e.g., fresh water) uses. Tanks, as they are not overflow most of the year, also give other resources such as silt, trees, and grass. Socially, tanks are sources of symbolic resources and are central elements of villages (Mosse 1997).

Tank controlling systems have been understood as public institutions that express social relations, significance, prestige, and honor (Singh 2006). Tanks also play an important role in ecological functions. For example, tanks play role in flood control and supply protection of the ecology of nearby area, besides providing habitat for a variety of many important species (Ratnavel and Gomathinayagam 2006). Tank

resources are helpful in ecological balance and many other sectors of the society. Approach to water and used for irrigation water tanks are best for all farmers in the tank command area. Water storage tanks is available to the whole population, not only farmers for domestic uses also in many village and in a specific area. Likewise, many other benefits from the tank resources (e.g., extraction of silt) also extent the entire population in a village (Palanisami and Meinzen-Dick 2001). More importantly, rights to fish, trees, and grass related with the tanks are often auctioned. Funds generated from tank resources are often expended on village social activities such as community based building construction like mosque and for other social welfare used (Janakarajan 1993; Meinzen-Dick 1984; Mosse 1997; Wade 1987). The modern software based technology has not only made if possible, but also good initiative to evolve computer based application to overcome the problem of storing, manipulating and analyzing large number of spatial data related to water resources problems and issue. Presently, many researchers and organization regularly use Geographic Information System (GIS) to estimate the effects related to the spatial variability of data (Leipnik et al., 1993). GIS can be successfully used in water resources modeling and mapping. GIS can also use to predict and monitor different source of pollution from agricultural areas and urban environments.

The impact of climate change on water storage options:

Environmental change will increment precipitation fluctuation and normal temperatures, influencing both the organic market side of the water system condition. In certain region of the world, yearly precipitation will decline, diminishing streams and groundwater re-energize. In different spots, absolute precipitation might increment however it will fall over more limited periods with more noteworthy power so that droughts are longer. Higher temperatures will increment dissipation so that yields will utilize more water. Albeit the impacts will differ from one spot to another, ranchers will by and large have to adjust to less soil dampness and higher dissipation. This implies bigger volumes and more incessant utilization of supplemental water. All capacity choices are possibly helpless against the effects of environmental change. The externalities made by various capacity types are additionally prone to be impacted by environmental change. Additionally, unfriendly ecological effects, emerging from changes in the stream systems of waterways, might be exacerbated by environmental change. Factors like these should be viewed as later on arranging, plan, and activity of water-stockpiling plans (McCartney, 2010).

The security is threatened on a community and global level by three important factors access and availability of food in local environments, effects of the changing climate on agriculture and natural resources, and active participation in planning, developing and managing effective strategies to optimize and sustain food production with the available existing land (kane 2014). In many countries food security has been measured and evaluated with various techniques and methods (mohammadzadeh 2010).

GIS and related spatial scientific procedures is one of these strategies that give a bunch of instruments to assessing and figuring out food security. A few systems have been created utilizing GIS and remote detecting strategies, which contribute information and understanding to food security. These systems incorporate procedures, which analyze nearby food conditions, evaluate changes in land use and land cover, and distinguish areas of significance in unambiguous locales to decide the connections among biophysical and financial traits. GIS assumes a huge part in getting the fate of our food creation and our populace. The significance of food security is straightforwardly connected to expansions in populace thickness, limits on agribusiness yields, and the spread of food deserts (kane 2014).

The Role of Water Storage in Climate Change Adaptation:

With expanded vulnerability, more popularity and more prominent rivalry, water capacity is just a single part of a multipronged approach for adjusting farming to environmental change. Future water

assets the board should likewise incorporate redistribution of water among clients and expanding water efficiency at every possible opportunity. There is no question that giving more and various actual stockpiling foundations is a basic for getting solid supplies of water for agribusiness and other use (Smakhtin, V. 2010).

Solid proliferation, actual development, mental and instructive execution, resistance, work limit, future, and personal satisfaction are key elements for accomplishing public human improvement in every general public. These variables are firmly connected with food and nourishment security. Food security has been considered as the need might arise, and, alongside essential medical care, as an essential for human turn of events (mcIntyre 2003).

Food security was characterized as a circumstance where all individuals, consistently, have physical, social, and monetary admittance to adequate, safe, and nutritious food that meets their dietary necessities and food inclinations for a functioning and sound life (FAO 2002). In other words, it is considered as a house-hold's availability to healthy food that is consistently accessible to sustain an active and healthy lifestyle (KANE 2014). The three determinants of food security are availability, access, stability, and utilization. Food availability is associated with geographical and agri-cultural determinants of each area, such as domestic production, import capacity, food stocks, water availability, agriculture land, population density and distribution (christian-sen 1995)

Materials and Methods

The study was conducted in the supervision of Dr Ishtiaq Hussain department of biological science university of baltistan skardu and the researchers collected data with the help of questionnaire and different software like ArcGIS, GPS Mobile app, google earth pro with two assistants fluent in Urdu, English and local language Urdu. Data collection is questionnaire based from the key informant of the area by group discussion, semi structured and individually. The total participants is 15 all was male and their age is (45 to 60).

Participant Observation

The researchers visited study Area Olding skardu for regularly for the observation, analysis, and for data collection in the month of (July and August 2022). During field work, researchers participated in the form of team based with different strategies to cover the area of the village olding. Notably, they accompanied people in their festive and work activities. Participant opinion allowed the understanding of the different ways in which resources from water tanks are used. We also organized group interviews to get a better understanding of the different assessments and uses of water tanks according to different social groups.

Survey

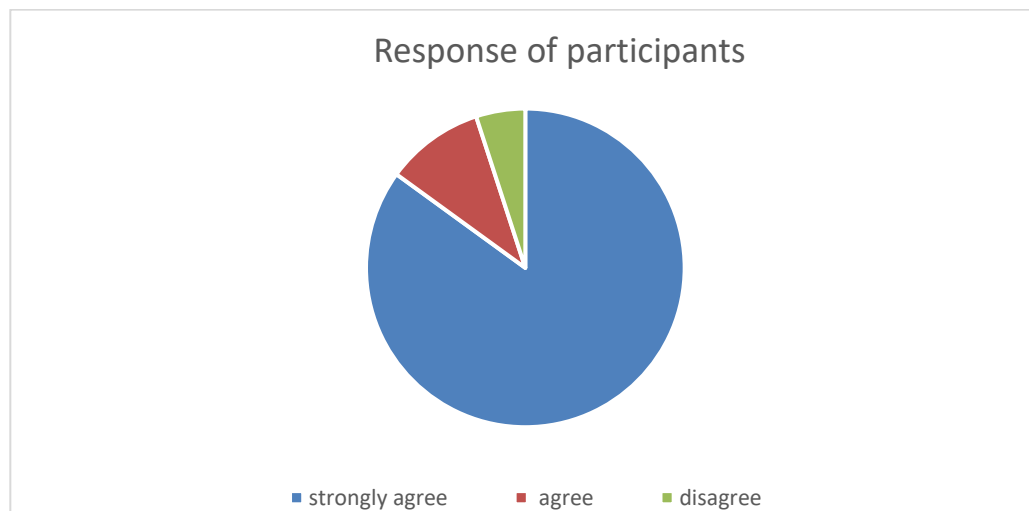
We conducted a survey in open field by randomly targeted household to collect information from the surrounding of water tanks. To select informants for the survey, we followed the same sampling strategy by questionnaire based from informants. the survey included 40 (15 were 50 years old people, 10 are women and 15 are young 25 years old) from different households of olding skardu.

These are the following Questions of questionnaire.

Q1. Do you think climate change effect the surrounding water tanks of the area?

- Q2. Due to disaster and natural activities mostly effect the quantity of water to reach at these tanks?
- Q3. Does overpopulation is one of the main causes of decline water level of these tanks?
- Q4. Do you think inventory can decrease the pressure of water demands?
- Q5. Do you think water levels decline in these water storage tanks as compared to past?
- Q6. Do you think awareness will help in conservation of these water storage tanks?
- Q7. Does proper water management through different strategies will be helpful for the community?
- Q8. Do you think migration of people is the main issue of water storage and climate change?
- Q 10. Do you think these water tanks have a vital role in agriculture purposes?
- Q11. Do you think with the passage of time the water level of tanks decreasing?
- Q12. Are you getting the right of using the water of these tanks to carry at your farmlands, or different agriculture lands?
- Q13. Have you listen before about climate change and global warming and their effects on organisms?
- Q14. Do you think overpopulation are threats to water shortage and food imbalance?
- Q15. Are you think that researchers should visit at your area and study about the issues regarding the agriculture and drinking water issues and their solutions?

Figure 1. The below chart shows the response of informants.



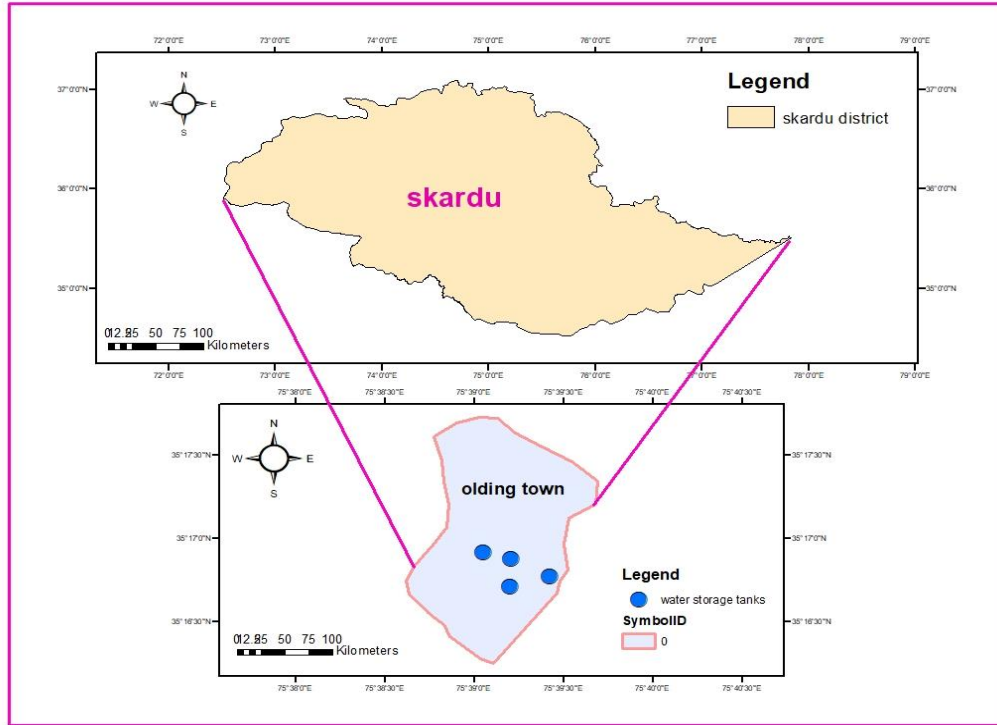
The survey was consist of 15 questions and the number of participants were 45 in which (15 were 50 years old people, 10 are women and 15 are young 25 years old) from different areas of olding skardu. Mostly the participants response are strongly agree and some response are agree and minimum response are disagree with the different questions about water tanks and its resources.



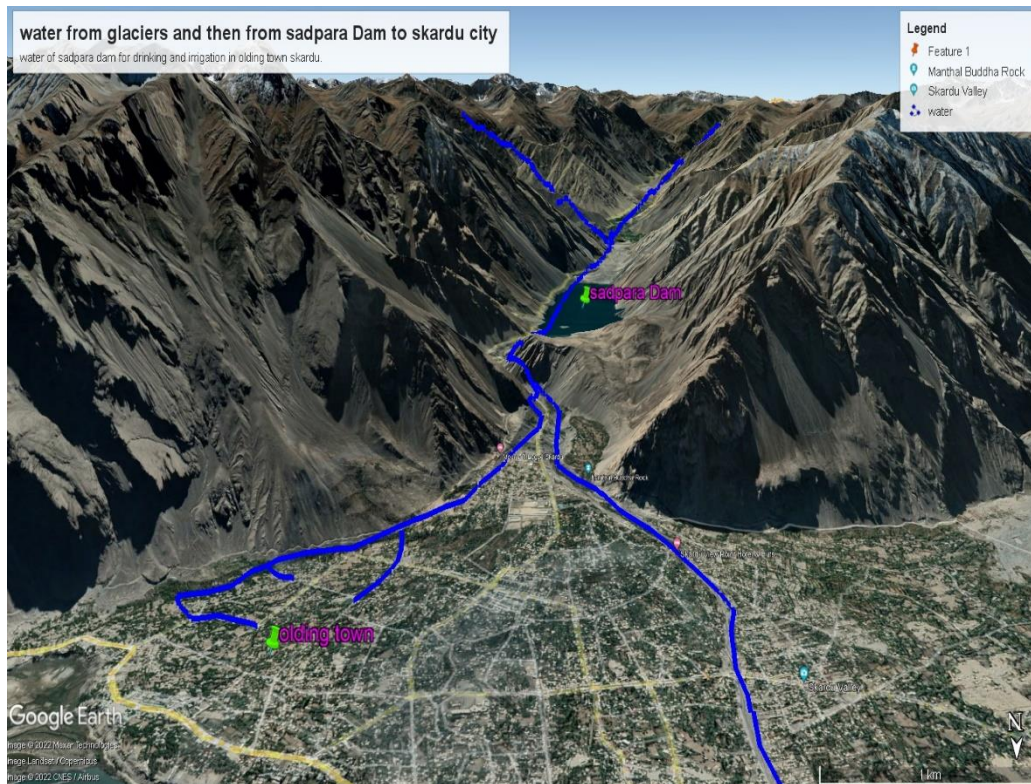
These are the different water storage tanks which is found in skardu town olding the local farmer are highly dependent upon these water tanks in related to agriculture purposes, and number 4 is highly used by the inhabitants of the area for agriculture commitments. The water storing capacity is vary among these tanks. Maximum water storage capacity is 3185645.24 liter.

Map of old town Skardu.

The use of GIS (geographical information systems) in water management explore the ideas about the relationship between climate change, catchment, agriculture, channel and society that emerged more than a hundred years ago. From these beginnings, hydrological GIS has come to be defined mostly by modelling in the science territory and by asset (notably infrastructur). In both contexts it can be determined that data quality represents the ultimate limitation, but that the expedition for higher resolution may carry with it some major problems. (1998 John Wiley & Sons, Ltd.) District skardu consist of four tehsil Tehsil Skardu, Tehsil gamba Skardu, Tehsil Gultari and Tehsil Rondu. The study area is a part of Tehsil Sskardu Main town in which different types of people are living like Balti, Shina are two main cast.



The study area olding is the main town area of Skardu district nearby City Park and Agriculture department and tissue culture lab. The main purpose of this study is to highlight the current location of water tanks by GIS which is still used by local farmers for the agriculture purposes.



The main source of this map is google earth pro to highlight the study area and its land covered areas. In this map the blue line are showing the water channels which are starting from the Sadpara Dam and it is divided into two parts one is towards the olding and its become reached into different water storage tanks and agriculture lands. On the right side the water channels are directly reached into the Indus River.

Result

Data Analysis:

Table 2.1 Different Water Storage And Its Capacity

S.no	Water tanks	Length	Width	Hight	Water storage capacity	Location in olding
1	T1 Small	60 feet	50 feet	5	424752.699	Pakora olding skardu
2	T2 Large	150 feet	130 feet	6	3865249.56	Gamba grong olding
3	T3 Medium	90 feet	75 feet	7	1146832.29	Nagxoq olding
4	T4 Large	180 feet	200 feet	9	9174658.3	olding center

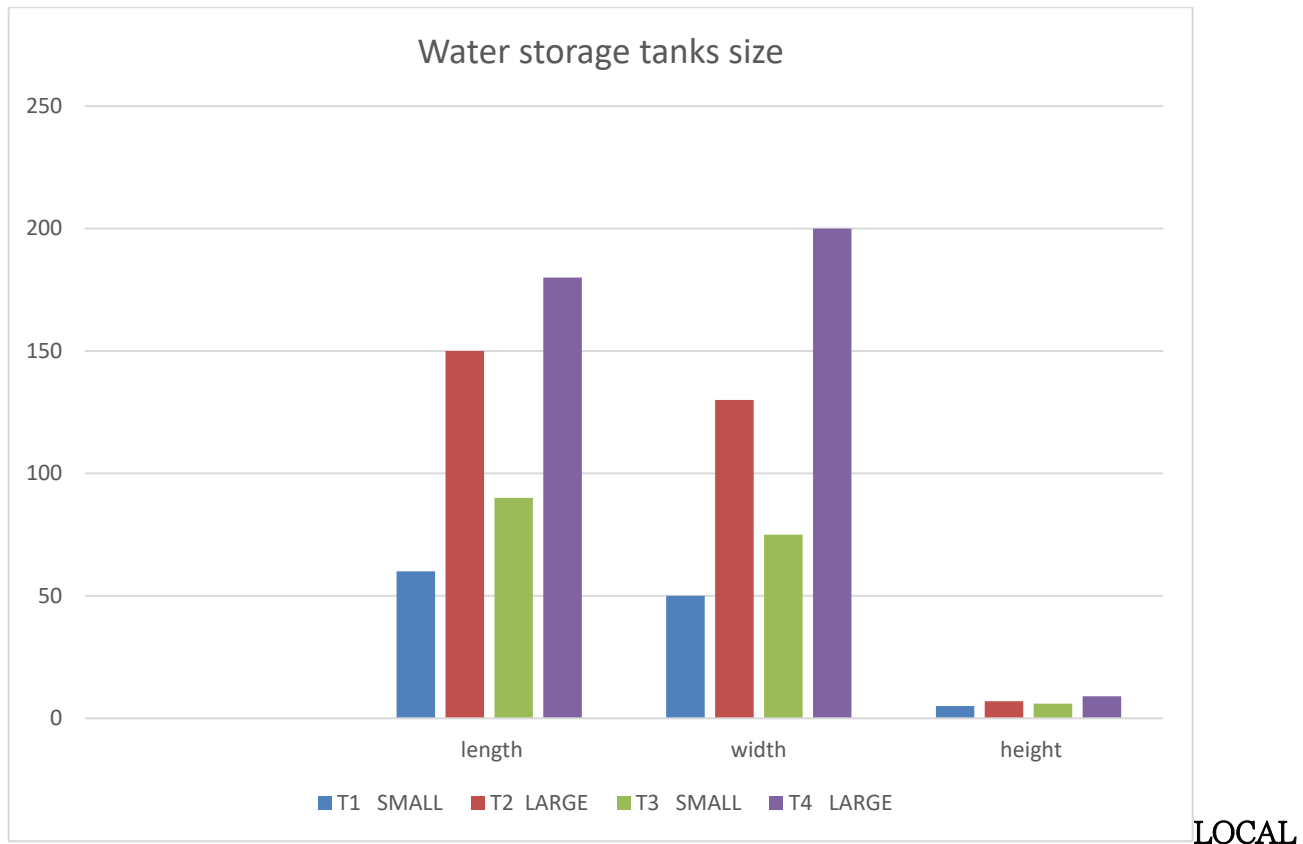
There are 5 to 8 water storage tanks are found in the surrounding area of olding town Skardu, the above mentioned water tanks are highly used by the inhabitants of the community for agricultural purposes. The result of this study also highlighted that with the passage of time the number of these water tanks also decreases due to many reasons like human activities and climate change (reference local people of the area). The water source for these water storage tanks is glacier water or sSadpara dam and springs water of Ryong Chumik olding which is 8 km distance from the village Olding.

TABLE 2. Water tanks and its storage capacity with main source.

S.NO	WATER TANKS	DISTANCE AMONG TANKS	WATER STORAGE CAPACITY (LITER)	WATER MAIN SOURCE	NEAR TWONS
1	T1 SMALL	70 M FROM T2	424752.699	springs and glacier	kuru
2	T2 LARGE	70 M FROM T1	3865249.56	sadpara	krasmathang
3	T3 SMALL	30 M FROM T1, T2	424752.699	sadpara	Abbas town
4	T4 LARGE	20 M FROM T1, T2, T3	9174658.3	sadpara glacier	division

- These water tanks are nearby with each other and mostly the agricultural lands are highly depend on these water storage tanks and play a vital role for the community of Olding.
- The water storage capacity is variable when different source of gradients attached with water and reached to the water tanks and it forms a compact layer on the surface.

Figure NO. 2 The Below Graph Indicates the Water Storage Tank Sizes.



PEOPLES ARE SUFFERING FROM WATERBORNE DISEASES.

- The residents are getting polluted water during summer but there is no well-developed water purification plant in the capital city.
- including diarrhoea
- typhoid
- Gastrointestinal diseases
- Hepatitis
- skin diseases
- Kidney diseases

DISCUSSION:

The research study was organized that the discussion are showing this findings and facts that arise from result, the result indicates that, without rejecting the importance of water tanks for agriculture and drinking purposed, the people of community also acknowledge about the importance of water and the multifunctionality of water tanks. Also the result shows that an inventory of water tanks also helpful in storing water and for preservation and to face future challenges with the passage of time. The Findings of this study also shows that local observation of water tanks as multifunctional. In compare to previous research (Palanisami and Meinzen-Dick 2001), the field survey represented that informants “insights many angle of the reasons why tanks are locally valued. We know that the maximum, but not overall, key informants highlight crop production and irrigation, drinking as the most relevant uses of water tanks.

Ten percent informants did not mention crop production or irrigation are related and have important reasons for the existence of water storage tanks and the traditional use of water storage tanks, which can be understood as indicator that the people of community recognize water tanks are important outside agriculture uses.

This research study also finds that the people of community are belongs to many cast like Balti, shina, local and non-local. The ratio of local people has less in number while the non-local high household and they have, minimum number of agriculture lands as compare to the local people of the area. We also came to know about that the local people has high right to use the water of mentioned tanks as compare to other cast. Local people are highly dependent on these tanks and their socio economic are related to these water tanks like their foods etc.

We conclude that mentioned some procedure issues that appear from our analysis, the result recommend that the local population seems to benefits from the variety of uses and function of water tanks, either the people use water tanks for irrigation or for other uses.

Conclusion:

It seems that lack of management, lack of public awareness, destruction of natural resources particularly deforestation have drastic effects for both water quality and quantity of these water storage tanks. Climate change, global warming and natural disaster like soil erosion, flooding, earthquakes and anthropogenic activities disturbing the vegetation, health and agriculture system of the area.

RECOMENDATIONS:

- For water management and monitoring in future physiochemical monitoring is very important.
- Future research on physical parameters, chemical parameters and biological parameters on these water storage tanks will helpful to provide safe water to the community of Oldingtoun Skardu.

Future GIS based study Play a vital role in.

- Mapping, modelling and highlighting the source of pollutants.

AKNOWLEGMENT:

I would like to thanks organizing committee and all members of **7th IWC 2022** and **RIPAH INTERNATIONAL UNIVERSITY and PCRWR** for providing this platform.

I am very thankful to my research professor, Dr-ishtiaq Hussain Associate professor Department Biological Science University of Baltistan Skardu for giving me opportunity to do research and providing valuable guidance and fulfilled all the requirements and needs to complete this research study.

I would like to thanks Haleema Ibrahim, Tahmina Ali and Shakeela Bano for their support and help in data collection during survey and the community of Slding Skardu for sharing valuable information and guidance. I would like to thanks Shafiqa Zehra, Taiba, Humaira, Zehra and Kosar for their support and guidance to carry out this research study.

I would like to thanks Sir Ishtiaq Hussain visiting faculty of department environmental Science University of Baltistan Skardu for his valuable guidance in related to ArcGIS.

I am also very thankful to all faculty members of Biological Sciences University of Baltistan skardu Dean Dr-Abdul Matin and Head of department Botany Dr-Alamdar Hussain and especially Dr-Akbar zaigham, Sajjad Hussain akhonzada, Dr-Askari, Dr-Munawar Hussain, Mam Syeda shehnaz for their encouragement, suggestion, and guidance, support for such research activities by the University of Baltistan Skardu.

Water Pollution and Water Waste Management

Amna Binte Fayyaz, Hamna Abbasi⁴⁴

Abstract

Water is the most essential thing for humans. But our oceans, rivers, and lakes are drowning in harmful chemicals, microorganisms, plastic, and other wastage causing water pollution. Water pollution occurs when the properties of water are changed which is mainly due to the discharge of harmful pollutants without any adequate treatment. Pakistan is among the most water polluted countries in the world according to a survey Pakistan has the most contaminated rivers in the world. The primary contamination source is the disposal of sewerage and animal manure; the secondary source is toxic chemical water disposed of by industries. According to UNICEF, 40% of deaths in Pakistan are caused by water diseases. The main reason for water pollution in Pakistan is the lack of water waste management and treatment, keeping in view the IMF declares Pakistan among the top 3 most water-stressed countries, and according to the UN by 2025 Pakistan will not have any clean water left to use, which is an alarming situation. This paper discusses the most popular water waste management treatment which is practiced around the world like the process of conventional and modern methods and how the sustainable approach of recycling water, including water treatment plants covert polluted water into clean.

Introduction

Water is a basic human need and Pakistan is facing numerous problems related to water. One of biggest issue is water pollution. 80% of Pakistanis are deprived of clean water. Water pollution is causing a lot of damage to Pakistan. It is instigating water related diseases, Economic loss, Agriculture loss and scarcity as well. Water pollution has become a nontraditional threat for Pakistan. The quality of drinking water positions at number 80 out of 122 in whole world. According to a report water bone disease adds up to 80% of all the disease of Pakistan and 33% of the deaths are caused by it. Unites Nation report states that due to the increasing population of Pakistan the demand of water by 2025 will exceed up to 274 MAF and the supply of water will be only 199 MAF, which will make Pakistan a water scarce country. Pakistan is an agriculture country at it can be said that agriculture is a main pillar of its economy. Water is the backbone of agriculture sector and by seeing all facts and figure it can be said that upcoming water scarcity can put a huge dent on economy of Pakistan and no doubt, it is an alarming situation and water pollution is already causing a loss of \$380 Million dollars to Pakistan's economy. This figure will keep on increase in future. To deal with all of this a strong water waste management is needed and in case of Pakistan it is very weak. This issue is not dealt with the way it should be. The paper discusses about the cause and effect of water pollution, water waste management and a case of Pakistan. The popular methods of water waste treatment of world are discussed, also how Israel is recycling 90% of its waste water, which is highest in world. This study elaborates tells about the importance and need of waste water management and why Pakistan lacks behind also that Pakistan can put all its water related problem to an end by recycling and reusing its water. This research also proclaims what's the way forward for Pakistan.

Keywords: Water pollution, Water Waste Management, Pakistan, Water Pollution in Pakistan

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Hypothesis statement

Water pollution and poor water waste management causing Pakistan an economic, agriculture and human lose, leading it towards water scarcity.

Research questions

The main focus of this research is on the following questions:

1. Water pollution in Pakistan, a threat to public health and sustainable development?
2. Is water waste management a viable way to pull out Pakistan from water crisis?

Research methodology

This research is descriptive and analytical. The data is taken from secondary source which is cited in references. Qualitative data is used to illustrate the affect and caused of water pollution and lack of water waste management in Pakistan. The information is taken from several websites, newspapers, journal articles and publications.

Literature review

One of the major threats to the life Pakistani residents is water pollution. Poor quality of water is being provided to the people of Pakistan for consumption. Water resources of Pakistan are contaminated with harmful pollutants from domestic, agriculture and industrial waste. In urban areas of Pakistan wastewater is majorly produced by domestic waste, in the big cities of Pakistan quality of water is extremely bad. Industrial effluents are being disposed off into the rivers, streams, lakes and all other water bodies which are contaminating the fresh available water for public use. Pakistan is an agricultural country while the fertilizers used in agriculture field contains harmful chemicals which can cause serious health problems to humans if consumed. In Pakistan agricultural runoff is disposed off into rivers, canals, oceans etc. Without any prior treatment. Due to Overlapping of institutional jurisdiction in the country the governance of water resources is not effective. Agricultural effluents are major pollutants but there is no policy to stop these pollutants from entering fresh water. Water pollution is as dangerous as air or soil pollution. Water is getting contaminated by different processes such as biological, physical and by dumping waste in solid form into the rivers, oceans and lakes etc, along with that acid rain also cause pollution to these streams. Weed and aquatic plants are growing rapidly their growth is making water flow difficult. The colour and smell of polluted water is changed and it affects the life of humans and animals badly. Water bone diseases are increasing in Pakistan, IMF ranked Pakistan at third position among the countries who are facing water scarcity, it is reported that after 2025 there will be no clean water in the country for use, water pollution is creating water scarcity in the country, it will not only effect the people of Pakistan, but the economic life of the country will also face problems. Diarrhoea, dysentery, typhoid, cancer is getting common in the country. Children are mostly dying because of water bone diseases in the country. In Pakistan the strategies for managing waste water is in dire need of time, whatever policies are present in the country are not being implemented properly. Lack of efficient water waste management is increasing the threat of water scarcity in the country. Water recycling and reuse is the only process to overcome scarcity. There are several waterwaste treatments which can be used at different levels such as industrial, agricultural and domestic level which will help in dealing all type of water problems. Municipal treatment plants should be installed at domestic level so that sewage can be treated from where it is generated this is based on conventional treatment process it involves three stages primary, secondary and tertiary, at primary stage solid waste is extracted from sewage at

secondary level dissolved matter is removed, while at tertiary level leftover chemicals are removed than the water became pollutant free and pure. In Pakistan at industrial level very few waste water treatment facilities are in access. Gujranwala is the industrial hub of Pakistan and a survey was conducted to check the quality of water it was reported that all the samples collected from different industries were below the standard of National environmental quality standard NEQS. An analysis shows that the water treatment plants which are available are not working well to make the water reuse able.

Water pollution; effects on public health and sustainable development of Pakistan.

When the harmful chemicals entered the natural water, the water became polluted. Water pollution is defined as the presence of harmful pollutants in the water which changes its characteristic and make it unfavourable for use. Nowadays water pollution has become the problem of whole globe. Throughout the world a large proportion of people are dying due to the diseases caused by water pollution. This problem is not just faced by developing countries but developed countries are also going through the same problem. Many factors are influencing the water quality such as climate, soil type, vegetation, geology, flow condition, human industries and municipalities, which are posing greatest threat to the water quality. Activities like mining, agriculture and urban development also affects the water quality. When the polluted water is used for drinking and domestic purpose it lays serious risk on the life of people, it causes several diseases such as typhoid, cholera and tuberculosis. In Pakistan the major cause of water pollution is lack of water treatment before its disposal. As Pakistan is an agricultural country it needs abundant water to grow crops every year but due to water pollution water scarcity is increasing and farmers are facing water crises to grow crops which is posing threat on the economy of Pakistan. In some areas of Pakistan polluted water is used for irrigation purpose which is very dangerous for human health crops grown by contaminated water cause health problems to the people who consumed such food.

Water pollution in Pakistan

In Pakistan water pollution and distribution of water has become life threatening. It has become serious environmental issue for animals, plants and human health. Large proportion of people in Pakistan depend on ground water both for domestic and irrigation purposes but in several part of the country ground water is declining due to mixing of saline water into non saline water areas it is predicted that in a near future 80% of ground water will sink. There is a conflict among different reports regarding the proportion of safe drinking water according to national statistics only 56% of total population have access to safe drinking water in the country. The drinking water that is provided to public by different municipalities is contaminated with different chemicals which cause health problem if consumed. In the twin city of Pakistan Rawalpindi and Islamabad an analysis was conducted which shows that 34% and 94% of water is contaminated with total coliform and fecal coliform. A detailed study was conducted by Pakistan council of research on water resources shows that 84%-89% sources of water all over the country is contaminated and below the recommended standard which is favourable for human consumption. Poor quality of drinking water forced the public to choose expensive alternatives such as mineral water. Mineral water is also not safe due to the lack of monitoring process in the country. Majority of people of Pakistan has low purchasing power so they cannot afford alternatives and use contaminated water for drinking purpose which cause serious health risk, the ratio of water bone diseases is increasing day by day.

Sources of water pollution

Following are the major sources of water pollution.

Industrial effluents

In Pakistan industries are mostly located in the big cities which are playing major role in increasing water pollution by discharging toxic water in rivers, streams, lakes etc. Waste water is directly discharged into rivers and lakes with only 1% of treatment in Pakistan. Around 80,000 m³ of industrial effluents which contains high level of pollutants are discharged into the river of Kabul daily in KPK, which is dropping agricultural productivity. Also, the fish population is decreasing and various diseases are erupting. The second largest industry in the country is sugarcane industry, it is also a major source of pollution, because of the large volume of waste water eradicate by it which contains heavy pollutants. About 10 million people relate to this industry either directly or indirectly. A study has shown that 76 factories are working and 369,000 tons of sugarcane is used per day so the waste water generated from this industry is several hundred thousand m³ per day. In Hyderabad the waste water generated from sugarcane industry is directly discharged into rivers, stream without any treatment. In Sindh out of 34 industries only 2 industries have installed water treatment plants which are due to international pressure as these industries are exporting products to International market.

Agro chemical waste

Water and electricity which is needed for irrigation in agriculture sector is subsidized for political purpose, due to this optimal practice are not adopted such as sprinkle and drip irrigation while wasteful flood irrigation is mostly used. Wise use of water is not encouraged due to the cropping and farming practices on the other hand water get waste due to breaches and seepage which cause water logging and salinity. Many chemicals such as fertilizers, pesticides are used in agriculture for the productivity of crops, Improper disposal of these agro chemicals contaminate the water bodies. Pesticides reach water bodies through surface runoff from agricultural field drifting from spraying cause water pollution. Most of these chemicals are non-biodegradable, which can cause bio magnification after reaching humans through food chain.

In Sindh the agricultural pollutants are threatening surface water, farms and health of people. The environmental protection agency mentions that pesticide standard 0.15mg/liter is discharge in underground water, which is polluting the inland water in Sindh, the agricultural land is surrounded by canal network system the discharge the overflow from agricultural land which makes water bodies polluted and it has produced water scarcity by deteriorating the quality of water and making it unsafe for use.

Domestic effluents

Waste water effluents produced from human activities in household are domestic effluents, it is the waste water from kitchen, shower, wash basin, toilet and laundry. It can be a yellow, brown, black and grey in colour. Domestic waste water is physically characterized as grey water, it contains musty odour and has about 0.1% of solid metal in it. Solid material is the mixture of faeces, toilet paper, metal, detergent and sand etc. Putrescible organic substances and pathogens are primarily produced by domestic sewage. Pathogens are disease causing micro-organism which is excreted feces is potential threat to the human health. Household waste water is released into the fresh water thus the fresh water get contaminated and poses health risk in humans. According to the report of PCRWR 73% of waste water is of residential origin.

- Global warming is another source of water pollution. Temperature of water is raised due to global warming; the raised temperature kills the water dwelling animals; the death of these animals causes more water pollution.

- When the garbage is dumped in water bodies, it causes water pollution. According to an estimate that 1.4 billion tons of waste is produced each year which mostly contain plastic a large amount of this plastic enter the ocean every year.

EFFECTS OF WATER POLLUTION

Human health and pollution

According to an estimate 40% of death in Pakistan is caused by water borne diseases. Public health in Pakistan is at risk due to water pollution. The presence of arsenic in drinking water can cause cancer, restricted pulmonary diseases, cardio vascular problems, diabetes, neurological impairment, kidney stone etc. In Pakistan million people are dying neither by natural disasters nor by terrorism but due to unsafe drinking water. According to UNICEF and health ministry more than 50,000 children are dying of water borne diseases such as cholera, dysentery, typhoid, diarrhea etc. Pakistan is currently spending half of its total health budget in treatment of water borne diseases.

Water scarcity and economic development

One of the biggest sources of water scarcity is water pollution. Polluted water is unfit for human consumption thus the increase in water pollution increase the scarcity of water. Among 17 water scarce countries Pakistan ranks at 14. One third of available water resources are being wasted. In Pakistan water resources are not enough to fulfil the need of growing population but the increase in water pollution is contaminating the already present water resources and make less availability of safe water for drinking purpose and less water is available for other activities. According to experts by 2025 Pakistan may face water short fall. Due to increase in water pollution Pakistan is facing the crises of safe drinking water thus the water scarcity is majorly caused water pollution.

Agriculture a source of economic development

Agriculture sector is playing important role in the development of country it is of great importance for Pakistan. 23% of Pakistan's GDP is generated from agricultural sector. This sector employs more than 45% of labour force. Foreign exchange income in Pakistan is majorly through this sector. 70% of livelihood of people of Pakistan depends on agriculture, it is a stabilizing factor for the economy of country. About 69% of total water present in Pakistan is used in agriculture or irrigation. Irrigation cannot be carried out without the availability of enough water. As water pollution is causing scarcity of water, it will directly impact the economic development of country which is possible through agriculture sector thus lose in agriculture and irrigation can cause the economic downfall in the country.

Fish population is harmed.

In Pakistan livelihood of large population is dependent on fisheries, it plays important role in economic development of country. Fisheries is at risk due to water pollution, when the toxic materials enter the water, the life of aquatic animals is being threatened. When pollutants enter the water, they cause algal bloom which is harmful for fish as fishes feeds upon algae. Pesticides and harmful metals can cause death of fishes. 400000 people in Pakistan depends on fisheries sector. Water pollution cause decline in fish population and can out an impact on the economy of millions of people. At national level Pakistan has earned 26.25 US dollars in 2021 by exporting sea food it shows that danger to the life of sea can affect the economy of country.

The affect water pollution is putting on different sectors be it economical or human, it shows that water pollution surely has become one of the biggest threats for the stability and growth of Pakistan and some great measures should be taken to strengthen Pakistan’s water waste management.

Waste water management and the case of Pakistan

Water waste management is very essential to keep the country’s water resources secure. Waste water management is a process in which water passes through a procedure and coverts the polluted water into clean. The process defines as collect, purify and recycle. In Pakistan it is estimated that only 1% of wastewater is managed and treated, be it industrial or domestic waste water. Another alarming situation is availability of water which is decreasing day by day. Pakistan’s water availability dropped from 5600 cubic meter to 1000 cubic meter which is leading Pakistan towards water scarcity, and right now only 20% of the population is getting clean water and rest 80% is using polluted water. Per year Pakistan produces 2301 million cubic meters of wastewater. Water pollution and wastewater is affecting Pakistan’s economy as well. It is estimated that every year Pakistan losses up to \$380 million dollars. Early 2.5 lac children lose their life to water bone disease caused by water pollution. All in all water pollution is causing Pakistan a heavy economic and human lose, leading us towards water scarcity and lack of water waste management is making the situation worse.

Is there any way out for Pakistan?

Waste water management needs to be strong in Pakistan. Some of the countries are recycling their waste water up to 90%, and 50% waste water of the world is treated and recycled through water waste management and Pakistan can also do so it just need a plane and execution. Here are some of the countries who tops the recycling water chart in world.

Country/continent	Waste water recycle %
Israel	90%
China	80%
Slovakia	65%
Europe	60%

Source: hydrotech Wastewater treatment across the world: which countries recycle the most and where is the best water quality?

Pakistan should also learn from world and should start its water waste management program at mass level and treat its polluted water by using world’s most popular methods, this is the only way out for Pakistan.

Popular waste water management treatment in world: There are several methods for the treatment of waste water in world. The most common treatments are physical (preliminary), biological (primary), chemical (secondary) and sludge treatment (tertiary/advance treatment). The combination of physical, biological and chemical treatment is called conventional method.

Physical (preliminary)

Physical or preliminary treatment involves the process of sedimentation, screening and skimming which eliminates the solids from water without using any chemicals. Sedimentation removes all the

dense in dissolvable elements from waste water, remaining unsolvable particles sits down at bottom and after that clean water can easily be separated from it. The next step of physical treatment is the process of aeration, the air passed through the water and the purpose is to run oxygen from water. The 3rd and last method is filtration, which filters all the impurities from water. The popular use filter around the world is sand filter it purifies the water deeply.

Biological (primary)

In biological treatment all the biodegradable matters like human waste and other organic matters like oil, soap and food are being removed and the microorganism assimilate all the biodegradable substances in waste water.

Three categories of biological water treatment

- Aerobic process: Converting biodegradable matters into carbon dioxide by decaying organic matter with the help of bacteria. This process includes the use of oxygen.
- Anaerobic process: Waste is fermented on certain temperature without a use of oxygen.
- Composting: This includes the procedure of mixing the waste water with carbon sources and sawdust as well.

This biological process separates all the solid items from wastewater except some soluble nutrients.

Chemical (secondary)

The chemical treatment involves the use of chemical in water to make it pure, the most popular oxidizing chemical, chlorine is used to make water free from any kind of germs and bacteria. There are other chemicals as well which cleans all the impurification of water and that is ozone. This process of adding chemical is used to make water neutral and bring it to its natural ph. level which is 7 and these chemicals prevent the production of bacteria in water and keeps the water pure.

Sludge treatment (tertiary/advance treatment)

The process of separating solid and liquid from waste water. Sludge treatment is used when some harmful substances are impossible to remove from biological process. It is mostly used to discard phosphorus and nitrogen from water, the device which is known as solid liquid separating device is used for extrication of all dense substances from water. Solid which is separated from waste water is called sludge and it can be use as fertilizer in agriculture.

Who leads the Waste water reuse in the world?

Israel is leading when it comes to waste water treatment. 70% of the Israeli land is desert and has dry weather, in 2015 the demand and availability of water reaches extremely low and the difference was of one billion cubic meters. Israel overcome this issue with the help of water waste management. It recycles and reuses 90% of its waste water which is the highest in world. Israel follow 3 steps treatment consist of physical, biological and chemical method. firstly, the water goes through the process of filtration in Shafdan waste water treatment plant then it goes through biological process and in the end, it passes through the natural filtration called soil aquifer treatment (SAT). This three-process treatment has helped Israel in overcoming water shortage and depending on any other country for water. Israel uses its treated waste water on agriculture, environment, industrial and for domestic usage, not only that, it exports its water as well, a country who was once facing the water shortage is now selling its water to world and that has been made possible only due to waste water treatment. Another step that was taken

by Israel to make people waste less water, which helped it a lot in water saving. Israel started a water saving awareness campaign with the help of tv radios and other public platforms it spread awareness, through which it saved 18% of its water which was being wasted earlier. Israel used both, technology and awareness for the better future.

Why Pakistan lacks behind in waste water management?

In case of Pakistan the policies are not adequate to deal with the severe crisis of water pollution and upcoming water scarcity. The government is barely working on this issue, one of the main reasons is lack of attention and budget allocation to water ministry. Water waste management is the need of time, it is the only way to save Pakistan from all type of water related crisis, be it economical, human, scarcity or pollution. All these problems require one solution which is, a good water waste management system. The government started a project to treat waste water under the supervision of national agriculture research center with the help of indigenous technology but till now not any kind of noticeable change has been seen in the water waste management. Neither the figures have changed, it is the high time for Pakistan to seriously deal with its water pollution and introduce a reliable and effective water waste management program so that it can deal with all the water related crisis and save Pakistan from this non-traditional threat.

Recommendations & conclusion

Pakistan can fight with water pollution and fulfill its water need, it can also handle the biggest upcoming threat of water scarcity and along with it, Pakistan will be able to overcome its economic, human and Agriculture loss. All of this can be made possible only with water waste management. Pakistan should use the popular waste water treatment discussed above to deal with all possible water issues. It can reuse its 100% of water with the methods that are discussed above. Government of Pakistan should pay special attention to it, they should also run awareness campaigns about water, telling people how important it is for our living and with the passage of time we are running out of this natural resource, a message should be spread country wide to not waste water and use it wisely. Through this we can reduce the ratio of water which is being waste and along with that a high level of water waste management program should be started throughout Pakistan and waste water treatment plants should be installed so that every citizen of the country can have this basic need and can use pure clean water. Pakistan should also raise all its water related issues internationally in United Nations and request them to allocate funds to Pakistan so that it can get out of this problem and save its citizens from water pollution, water diseases, Agriculture and economic loss and save their country from upcoming scarcity.

Development of Titanium Dioxide Nanoparticles (TiO₂ NPs) by Sol-Gel method to control Persistence organic Pollutant atrazine from drinking water

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Abstract

Water pollution is a serious threat to living entities on the earth planet, which has detrimental impacts on human health, agricultural, and aquatic life. . The most hazardous class of Chemical water pollutants is POPs (Persistent organic pollutants), applied to control insects and unwanted weeds from an agricultural perspective. Worldwide, the most widely used POP is Atrazine which is classified as an organochlorine-herbicide pesticide (OCPs), to kill unwanted weeds such as broadleaf weeds and Spanish needles. Atrazine has lethal impacts in 2 to 15 µl/L doses on fish species like grass carp. The atrazine pesticide type S-triazine mainly caused endocrine disruption in pregnant women, infant's growth retardation, physiological, and physical disorders. Moreover, Atrazine inhibits the microalgae; that survive in aquatic water bodies to fulfill the nutritious requirements of aquatic life. For, the transition metal (Titanium dioxide) nanoparticles are highly sensitive to removing atrazine pesticides, because of their high porosity, large surface-to-volume ratio, smallest particle size, and high adsorption capacity. To check the effectiveness of TiO₂ NPs, the UV-Spectroscopy of synthesized TiO₂ Nanoparticles was determined in the absorption range of 300-700 nm, which reveals the strong absorption peak of UV-Visible spectroscopy to remove atrazine (POPs) from real water sample. Therefore, the nanotechnology is a highly reliable, economically viable, and Eco-friendly technique to overcome the issue of persistent pollutants in water and to save aquatic life.

1. Introduction

In Worldwide countries, the quantity of herbicide atrazine pesticide was found in drinking water up to 0.01 to 6µg/liter, due to its significant applications in agriculture sites, atrazine considered as a crucial requirement of agriculture products having toxic effects on aquatic life. Atrazine herbicide pesticide caused system alteration in freshwater fish species especially Ctenophryngoden Idella (grass carp) by decreasing the level of essential fatty acids such as Triglycerides(TG),High Density Lipid (HDL), Cholesterol(CH) and Low-density Lipid(LDP) at certain dose level of atrazine from 2 to 15 µl/l. Despites banned on atrazine in several countries, the drinking water sources are continuously contaminating by the extensive use of Atrazine herbicides pesticides mostly occurred are Desthylatrazine (DEA) and Deisopropylatrazine (DIA) respectively [2].The more severe impacts of S-triazine (atrazine herbicide pesticide) on human health are the disruption of endocrine system in pregnant women, Infant's growth retardation, physical, and physiological disorders consequently. *To overcome this issue*, Nanotechnology is the innovative, convenient and safe solution to control persistence chemical pollutants from water , having manipulation of atoms on a nanoscale. In Nanotechnology, nano-size particles or membranes are used for softening the water and removal of different contaminations includes physical, biological and chemical [3].The Nanotechnology is the advanced, cheaper, innovative and scientific approach to develop the valuable nanostructures on nano scale size starts from 1 to 100

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nm [4]. Nanoparticle has broader applications in applied science such as absorbent, catalyst, greener reducing agent, sensors, nano membranes, semiconductors and etc [4]. Nanostructures lying at least 1, 2 and 3 dimensions with different morphological appearances like circles, rods, hollow spheres, disks, cylinders, tubes, spheres, platelets etc. There are various development/synthesizing methods for nanoparticles such as gas, liquid or solid phase approaches [5]. The applications of nanoparticles meet the specific functionality according to the targeted surface structure [5].

The production of Titanium tetraisopropoxide nanoparticles by Sol-gel method through Top-down approach is a cheaper and convenient technique to remove POPs from drinking water. For this, the modification of TiO₂ nanoparticles by calcinations step increased the efficiency of lab-based fabricated TTIP NPs after grinding. The purpose of calcinations by giving high temperature to reduce the moisture inside nanoparticles and helps to reach at nano scale size, induced porosity and finest size of nanoparticles. The suitable calcinations temperature for Titanium dioxide nanoparticles was found 500-600°C. To check the characterization of titanium dioxide nanoparticles the convenient and efficient technique that is UV-visible spectrophotometry helps to generate UV-absorption peak which helps to know the super-functionality of TTIP nanoparticles for chemical water pollutant removal [6].

The effectiveness of Titanium dioxide nanoparticles depends upon particles size, which found mostly in the range of 10-30 nm in many literature to capture water pollutants certain specific types such as chemicals and biological (algal anti-fouling of specific species like *Dunaleila salina*) [7,8,9,10,11]. The lab-scale fabricated Titanium tetraisopropoxide (TTIP) nanoparticles bind with atrazine herbicide pesticide persistence organic pollutant (POPs), to adsorb atrazine nanoparticles on nanoparticles surface, the effective and functional particles size existed in the range of 13 – 16 nm [12].

Moreover, there are various characterization methods to check the activeness of fabricated nanostructures such as X-ray diffraction (XRD), Scanning electron microscopy (SEM), Fourier transform electron microscopy (FT-IR) UV-Visible spectrophotometry and atomic force microscopy (AFM) etc, which characterized according to surface structure of nanoparticles to contact with target pollutants [13].

Beside this, titanium dioxide nanoparticles have several potential environmental applications, like photocatalytic degradation of atrazine, antifouling activity for marine algae and antibacterial characteristics for outdoor windows self-cleaning. Moreover, TiO₂ Nanoparticles have broader applications in industrial wastewater treatment to zero waste liquid discharge by an alternate and efficient semiconductor TiO₂ photocatalyst method to remove persistence organic pollutants from wastewater. The semiconductor titanium dioxide photocatalyst is found as cost effective, eco-friendly and sustainable wastewater treatment technology [13,14].

However, TiO₂ nanoparticles have wide applications for both persistence organic pollutant POPs degradation and disinfection of microbial contamination by linked with emerging technology such as TiO₂-tubular UV-Photocatalytic electronic device which is smart and inexpensive to install in small space [15]. The present study is aimed at the fabrication of most encouraging and efficient transition metal oxide (Titanium dioxide) nanoparticles by Sol-(solution-), gel(molten) method by top-down approach to remove herbicide (atrazine) pesticide from real water samples.

2. Materials and Methodology

2.1. Material. Titanium tetraisopropoxide (TTIP) 97% wt., Methanol (MeOH) 99.9% wt., D.I water, Nitric acid (HNO₃) 68% wt., were purchased from sigma Aldrich online website [6].

2.2 Fabrication of Titanium tetraisopropoxide (TTIP) Nanoparticles by Sol-Gel Method

To synthesize TiO₂ nanoparticles by sol-gel method, the first step was carried out by stock preparation in the molar ratio of TTIP:MeOH of 1:15. The prepared stock then stirred on magnetic stirrer for 45

minutes .After that, the hydrolysis step of titanium dioxide solution carried out by adding distilled water with a molar ratio of TTIP:DI water of 1:4.To maintain the PH of stirring solution ,65% wt. Concentrated nitric acid(HNO₃) was added dropwise until the ph reached 1.5.After Ph adjustment , the pale yellowish white sol-was formed which further more stirred overnight for 24 hours continuously on magnetic stirrer. The white sol-gel was appeared in flask which centrifuged at 10,000 rpm for 15 minutes until the pure white colloidal material observed in falcon /centrifuge tubes. After the formation of white colloidal TiO₂-sol, added the distilled water into centrifuge tube/falcon tubes to washed the sol-gel. After washing the TiO₂ Sol-gel, the sol-gel or xerogel was collected in crucible with the help of spatula and kept in oven for drying at 110 °C for 24 hours to remove organic solvents from TiO₂ sol-gel. The dried TiO₂ nanoparticles sol-gel then ground with agate mortar without beating but round ball-milling method of grinding to make porous and finest particles .Finally, the milky white TiO₂ nanoparticles was formed which placed in muffle furnace for calcinations to reduce the moisture content of nanoparticles at different temperatures start form 300 -800°C.After done the calcinations step , the calcinated TiO₂ nanoparticles was grinded again to reached the nano-scale size from 13 to 30 nm respectively.



Figure 1. Shows the Titanium dioxide Nano particles Fabrication by (Top-down approach) experiment in Lab

3. Results and Discussion

The fabricated TiO₂ nanoparticles (synthesized by top-down approach) was shown the effective absorption peak of uv-visible spectrophotometry. The range of UV-visible absorption peak from 200-600 nm which shows the effective porosity, tensile strength and high surface to volume ratio to capture atrazine pollutant itself. For this, the sonicated titanium dioxide nanoparticles mixture was run in uV-Visible spectrophotometry to check out the TiO₂ particles wavelength of absorption of Ultraviolet visible light. This characterization method generated reliable results for the effective functionality of TiO₂ nanoparticles.

Before getting Ultraviolet visible-spectrophotometry spectra of TiO₂ nanoparticles, the ultrasonication step was followed in lab by diluting TiO₂ nanoparticles in distilled water in cuvet. Prepared blank

reference material of ethanol and D.I water and compared the spectral results of two blank reference material for spectrophometry. The adequate time for ultrasonication of TiO₂ nanoparticles was found 20 minutes (180W) to make the suspension of TiO₂ before UV-absorption peak. By following 20 minutes sonication time , the solution remain stable for more than 1 hour [16].

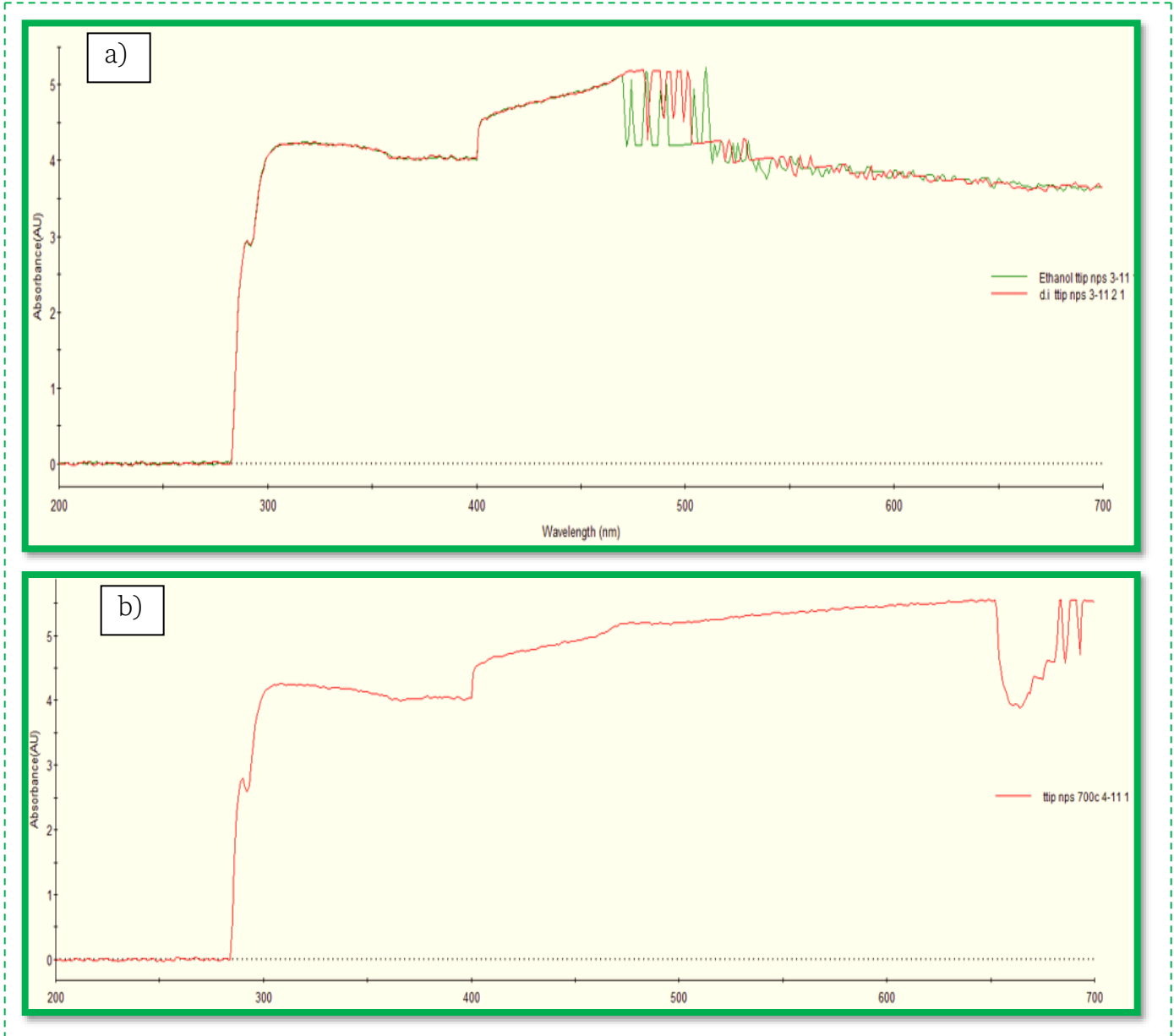


Figure 2. Shows the UV-Visible spectra of TiO₂ nanoparticles; a) shows the TiO₂ diluted with ethanol reference material calcinated at 500 °C, b) Shows the TiO₂ nanoparticles diluted with D.I water as reference material and calcinated at 700°C

The Sol-Gel fabrication method for TiO₂ nanoparticles yields high crystal oxides which act as regulator to TiO₂ nanoparticles by developing modified surface morphological characteristics like nanoparticles size and properties. In this technique of synthesizing TiO₂ nanoparticles, the titanium tetrapropoxide used as precursors which is easy to operate in different concentration [17]. The Sol-Gel technique for TiO₂ fabrication basically relied on calcinations step which act as crucial and necessary changes like decreased moisture content by allowing different temperatures ranges from 200 – 1000°C [13].

The fabricated Titanium tetrapropoxide (TTIP) nanoparticles have shown their effective functionality in antimicrobial activity against two bacterial species of *Pseudomonas aeruginosa* and *Staphylococcus aureus* [13]. Like this, TiO₂ nanoparticles sheets as solar absorber used for desalination water treatment process by changing aging times like 40 minutes, 50 minutes and 60 minutes [17].

4. Conclusion

In this present work, we have conveniently fabricated TiO₂ nanoparticles by cost-effective and time saving Sol-(solution-) and gel(molten) method related with other technique like electrospun nanofiber membrane. The fabricated TiO₂ nanoparticles will incorporated and sprayed on nanomembrane to remove pesticides (atrazine) residual from real water samples. The fabrication of nanoparticles is a very careful and challenging step to produce TiO₂ nanoparticles in lab instead to go for purchasing from market that is very expensive and poor quality of material with no reliable and efficient removal and have low tensile strength. The present work will also highlight the women-entrepreneurship of nonmaterial to sort out different challenges related with water quality to save water quantity (water conservation) by recycling and re-use of wastewater. The major concern to remove atrazine with the help of TiO₂ nanoparticles is human health because persistence organic pollutants persisted inside living tissue for longer period to time and cause DNA damage especially in pregnant women. Like this, other living entities such as fishes (major source of diet) will potentially and lethally affected by atrazine. So the fabrication by researcher and scientist is the big and initial step to generate effective material to cope up bigger problem.

Impact of Hand Washing Practices Using Educational Interventions on Orphan Children of Sindh.

Afsheen Tunio, Dr. Jamil Ahmed⁴⁸

Abstract

Orphaned children are a vulnerable population that is particularly susceptible to contagious diseases. It has been determined that the majority of health problems affecting orphans are led by poor hygiene, which may be prevented by adhering to basic hygiene guidelines. Interventions including hand washing are effective in lowering the prevalence of common illnesses. This study was conducted on the orphan children of Sindh. Two districts of the Hyderabad division were selected (Hyderabad and Jamshoro). One was governmental (Darul Ehsas in Hyderabad) and the second was non-governmental (SOS children's village in Jamshoro). Pre-assessment, educational interventions, and post-assessment were the three aspects of this study. Utilizing a designed questionnaire on hand hygiene behaviors, the assessment aspect was completed. Questionnaire was designed by 15 questions regarding hand hygiene such as hand wash before and after the meal, after the defecation, utilizing public transport, and after coughing or sneezing. Designed checklist was also used to observe the method of hand washing. Educational interventions introduced to the orphaned children of both orphanages includes hand hygiene kit (soap, leaflet and a hand towel), lectures including (importance, right moments, significances of hand drying and proper duration of hand washing), video sessions on correct method of washing hands, demonstrations, and displayed posters on walls. Microsoft Excel and Statistical package for social sciences software were applied to analyze the information gathered from the survey used to assess the hand washing behaviors pre and post-interventions. Our study revealed these findings regarding hand hygiene practice before the meal (43.7%), after the meal (38.5%), after defecation (77%), before sleep (23.7%), after utilizing public transport (3%), after sneezing, coughing or nose blowing (11.9%). The improvement were seen in post-intervention, before the meal (75.7%), after the meal (75.7%), after defecation (98%), before sleep (91.2%), after utilizing public transport (53%), after sneezing, coughing or nose blowing (85.3%). The outcomes of hand washing steps in pre-assessment, only 88.1% rubbed the dorsal side, 62.2% rubbed the palm, 24.4% cleaned the fingertips, 14.8% scrubbed between fingers, and 0% dried hands. While the improvement was seen in post-intervention 91.9% rubbed the dorsal side, 75.7% rubbed the palm, 43.4% cleaned the fingertips, 35.3% scrubbed between fingers, and 27.2% dried their hands. The children ranging between ages 7 to 10 and 11 to 14 had adequate hand hygiene practice as compared to children between 3 to 6 ages. So it is concluded that overall hand hygiene practices improved in post-intervention. To enhance the children's hygienic practices, educational interventions must be implemented in other orphanages. Each toilet door should have promotional posters describing proper hand washing methods and right moments.

Key words: Hand washing practices, assessment, educational interventions, orphan children.

1. Introduction

Orphaned children are a vulnerable population that is particularly susceptible to contagious diseases. An orphanage acts as a facility to provide assistance and care for children when they lack parents, care takers, or relatives to take care of them [1]. It has been determined that the majority of health problems

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affecting orphans are led by poor hygiene, which may be prevented by adhering to basic hygiene guidelines [1]. Children's hand washing habits should not be ignore because many illnesses are transferred on by having dirty hands [2]. Interventions including hand washing are effective in lowering the prevalence of common illnesses [3]. A child dies each minute as a result of inappropriate hand hygiene-related illnesses that have increased childhood death rates and morbidity [4].

As stated by World Health Organization every year, diarrhea leads to the deaths of 1.7 million children under the age of five [5]. Therefore, a proper hand washing practice can significantly lower the risk of respiratory and GI infections [4]. According to reports, hand hygiene initiatives in schools may increase academic performance by lowering the incidence of illness and absenteeism [6, 7]. Additionally, health professionals and experts around the world encourage using appropriate hand hygiene techniques to avoid the spread of viruses by preventing contact with infected people or areas [8]. Children under five must be incapable of adopting appropriate hygiene practices and knowing the importance of proper hand-washing behavior. Consequently, parental supervision and special care are needed [9].

The school seems to be important in modifying the children's behavior and personal hygiene practices as well as their wellbeing. The knowledge of proper hand washing techniques acquired in school can influence the habits of individuals and their families [10]. Using soap and educational interventions for hand cleanliness have been shown to reduce the risk of respiratory infection by 37 to 72% [11].

As stated in comprehensive report, hand washing reduces the risk of bird influenza by 50%, shigellosis by 60%, and diarrheal illnesses by 40% [12, 13]. Insufficient facilities, such as sinks, detergents, and water, low educational understanding of regular hand washing, and inadequate knowledge about the significance of hand hygiene habits have all adversely affected involvement and improvement [14]. While hands are thoroughly washed using running water with detergent rubbed, cleansed, and wiped during the key moments, such as before and after meal, after toilet, whenever using any contaminated things, and after having played, it can lower the risk of disease [12, 13, 15]. Pictorial representations that explain the proper way to wash hands and encourage the public to do so promptly could be publicized via electronic communication, news channels, posters, etc. Special television commercials and advertisements with promotional messages that raise awareness of this worldwide problem may be successful in encouraging individuals to follow proper hand hygiene habits [16].

children who live in orphanages are more susceptible to a number of diseases, such as skin infections, abdominal and intestine inflammation, and respiratory illnesses like COVID-19 due to the congested living conditions, poor housing conditions, lack of basic hygiene services, and probable issues obtaining medical care [17]. So this study was conducted on orphan children of Sindh to explore the impacts hand washing practices using educational interventions.

The overall aim of this study was to investigate the impact of hand washing practices using educational interventions on orphan children of Sindh. The specific objective of this study was to assess and explore the impacts of the hygiene practices and examine the effect of age on hand washing behavior.

2. Material and Methods

2.1 Study area

This study was conducted on the orphan children of Sindh. Two districts of the Hyderabad division were selected (Hyderabad and Jamshoro). Two orphanages were selected for this study one was governmental (Darul Ehsas in Hyderabad) and the second, was non-governmental (SOS children's village in Jamshoro).

2.2 Sampling

All the children of (SOS Jamshoro and Darul Ehsas Hyderabad) were selected for the assessment of hand hygiene practices. A total of 72 children were enrolled in SOS Jamshoro of which 24 were girls and 48 were boys. And 64 children were enrolled in Darul Ehsas Hyderabad, all were boys. By using random sampling, children were equally grouped into two groups; intervention and control group. Educational interventions include hand washing kits, Educational seminars about hand hygiene practices, videos, and different activities that were exposed to the intervention group only, to see the outcomes of the intervention.

2.3 Assessment of hand washing practices before intervention

All the children of SOS Jamshoro and Darul Ehsas Hyderabad were assessed before exposure to intervention using a questionnaire about hand hygiene practices taken from the study [18]. The questionnaire was of 15 questions on hygiene habits and hand washing *practices such as washing hands at the right moments (before and after the meal, defecation, sneezing, or touching animals or garbage*. All the questions were in the English language with three options always, sometimes, and never.

2.4 Educational intervention phase

Educational intervention was exposed for the period of three months. Following were the activities related to hand hygiene practices exposed to the children in intervention group.

2.4.1 Educational seminars

The children of both orphanages were selected for educational awareness seminars on hand hygiene practices. The seminar includes basic knowledge of hand hygiene, the significance of washing hands, the correct way to wash hands, the right time for washing hands, the proper duration of hand washing, and the importance of drying hands with a towel. The educational seminars were exposed to both groups of orphaned children and carried out every week.

2.4.2 Hand hygiene kit

Each intervention group participant from both orphanages received a hand hygiene related kit one time only, which included soap to wash hands, a booklet on the proper washing procedure, and a hand towel to dry hands.

2.4.3 Presentation of video clips

The children in the intervention group of both orphanages were exposed to video clips on proper hand washing procedures (WHO). Video clips presented basic steps of hand washing with soap according to the world health organization such as wet hands, scrubbing the top and bottom of the hands, rub the fingernails, between the fingers, thumb, and wrist. Once a week, the video clips were presented.

2.4.4 Display posters

Posters regarding hand hygiene practices include a poem about the proper method of washing hands, step-wise illustration, and the significance such as the right time to wash hands were displayed on the wall of each class of both orphanages. The posters were displayed one time only.

2.4.5 Demonstration of washing hands

The children of both orphanages were requested to wash their hands to observe their hand-washing method. Children's hand washing steps were noticed using a checklist taken from the study [19]. The checklist was of 8 steps about hand washing with two options. Children were requested to wash hands before and after the intervention to see the outcomes of intervention.

2.5 Assessment of hand washing practices after intervention

To assess the impacts of the intervention, all children enrolled in both orphanages SOS and Darul Ehsas were assessed using the same survey questionnaires that were used before the intervention.

3. Results

3.1 Assessment before intervention

Microsoft Excel and Statistical package for social sciences software were applied to analyze the information gathered from the survey used to assess the hand washing behaviors before and after the intervention.

Figure 4 Assessment before intervention

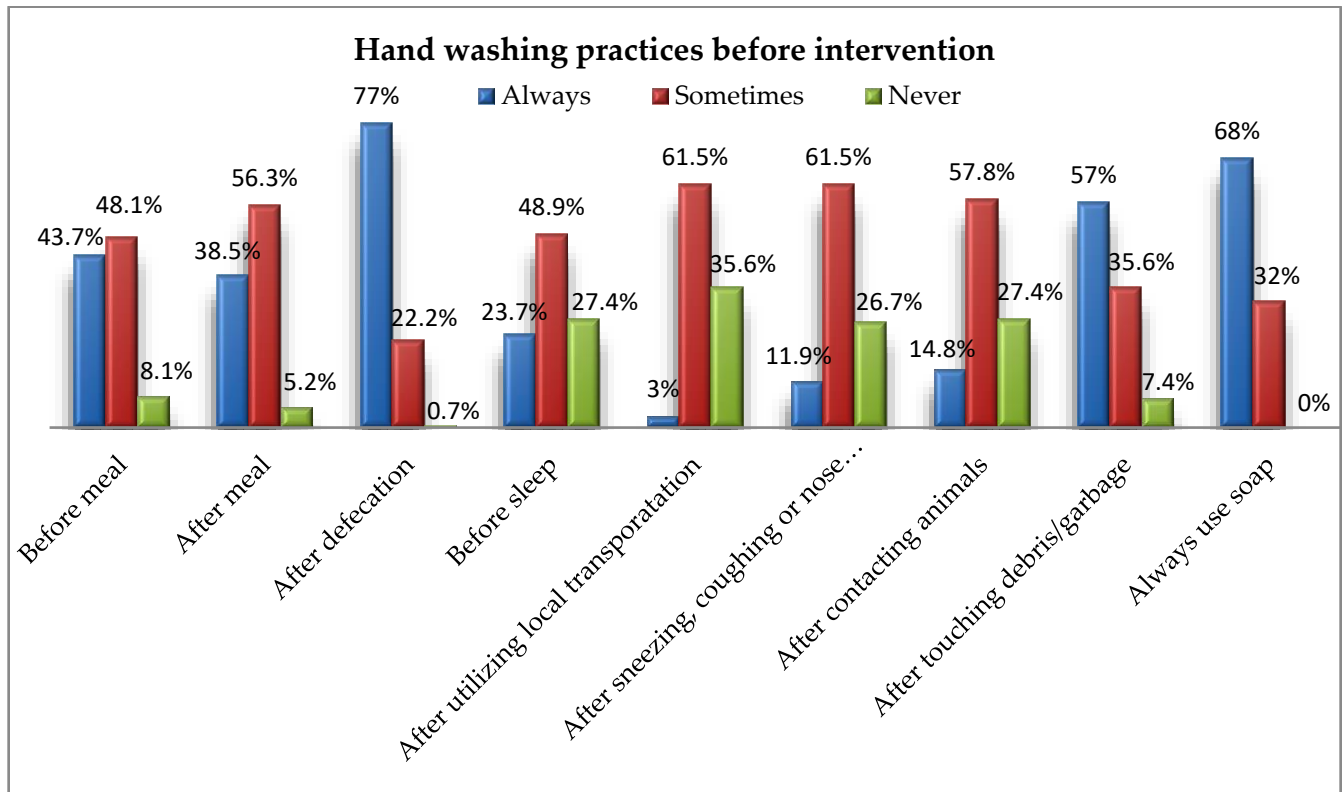


Figure 1 shows that prior to intervention, only 43.7% of orphaned children practiced hand washing before the meal, 38.5% practiced hand washing after the meal, 77% practiced hand washing after

defecation, 23.7% practiced hand washing before sleep, 3% practiced hand washing after utilizing public transport, 11.9% practiced hand washing after sneezing, coughing or nose blowing, 14.8% practiced hand washing after contacting animals, 57% practiced hand washing after touching debris or garbage and 68% of orphaned children practiced hand washing with using soap.

Figure 5 Assessment before intervention

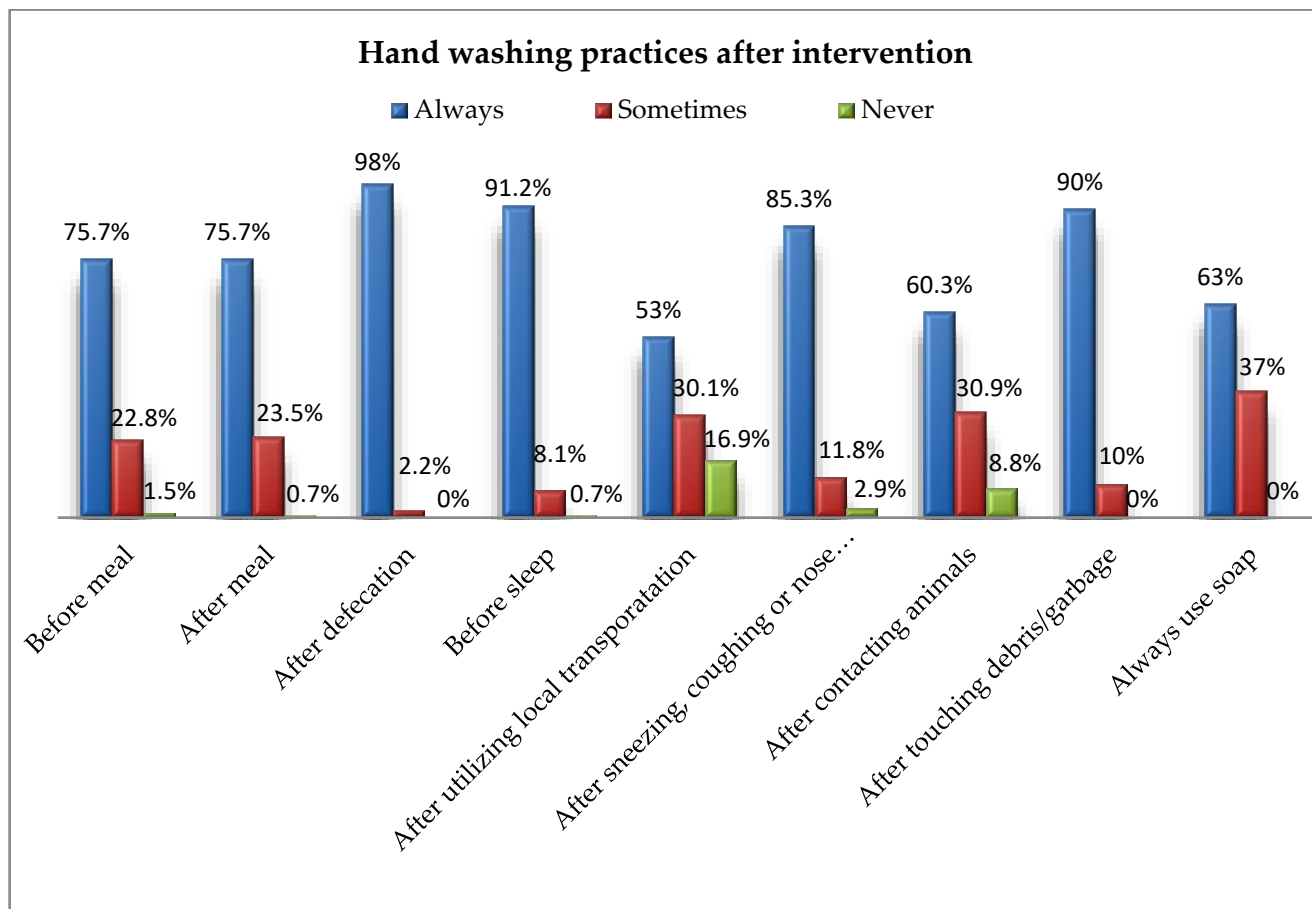
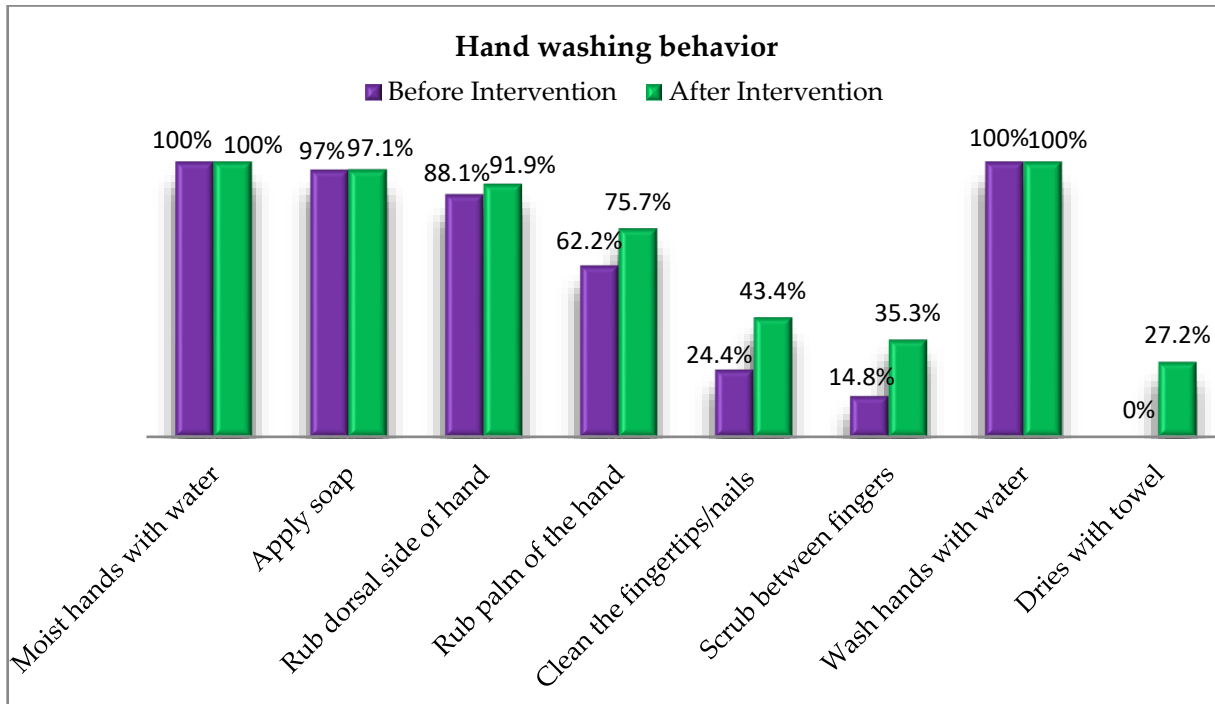


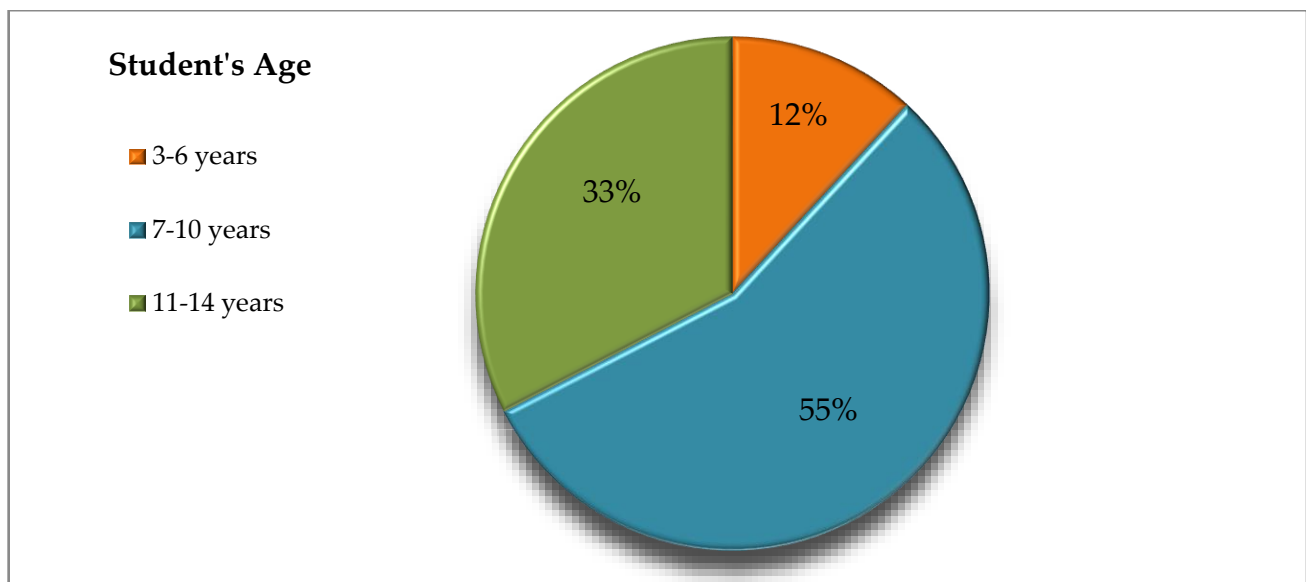
Figure 2 shows that post-intervention, 75.7% of orphaned children practiced hand washing before the meal, 75.7% practiced hand washing after the meal, 98% practiced hand washing after defecation, 91.2% practiced hand washing before sleep, 53% practiced hand washing after utilizing public transport, 85.3% practiced hand washing after sneezing, coughing or nose blowing, 60.3% practiced hand washing after contacting animals, 90% practiced hand washing after touching debris or garbage and 63% of orphaned children practiced hand washing with using soap.

Figure 6 Hand washing behavior observation



As figure 3 shows hand washing behavior of children in pre and post-intervention, only 88.1 % of orphaned children rubbed the dorsal side of their hands, 62.2% rubbed the palm of their hands, 24.4% cleaned the fingertips or nails, 14.8% scrubbed between fingers, and 0% dried hands prior to the intervention. While the percentage rise in post-intervention to 91.9% rubbed the dorsal side of their hands, 75.7% rubbed the palm of their hands, 43.4% cleaned the fingertips or nails, 35.3% scrubbed between fingers, and 27.2% dried their hands.

Figure 7 Student's age



A total of 136 orphaned children were assessed in the pre and post-intervention, the children were divided into three age groups: 12% were part of 3 to 6 years, 55% were part of 7 to 10 years, and 33% were part of 11 to 14 years.

Table 1: 3-6 years

S. No	Questions	Prior to Intervention			Post Intervention		
		Constantly %	Occasionally %	Not at all %	Constantly %	Occasionally %	Not at all %
1	Wash hands before meal	18.8	62.5	18.7	46.7	46.7	6.6
2	Wash hands after meal	0	81.2	18.8	46.7	46.7	6.6
3	Wash hands after defecation	37.5	62.5	0	86.7	13.3	0
4	Wash hands before sleep	31.3	37.5	31.3	80	20	0
5	Wash hands after utilizing local transportation	0	56.2	43.8	33.3	46.7	20
6	Wash hands after awaken	75	12.5	12.5	66.7	13.3	20
7	Wash hands after contacting animals	12.5	62.5	25	86.7	13.3	0
8	Wash hands only when dirty	87.5	6.3	6.2	100	0	0
9	Wash hands after sneezing, coughing or nose cleaning	18.8	62.5	18.7	33.3	46.7	20
10	Wash hands after touching debris/garbage	81.2	18.8	0	86.7	13.3	0
11	Wash hands before contacting ill person	6.3	12.5	81.2	26.7	33.3	40
12	Wash hands after contacting ill person	6.3	37.5	56.2	26.7	33.3	40
13	Always use soap for washing hands	62.5	37.5	0	46.7	53.3	0
14	Is towel available in toilets?	18.7	68.8	12.5	33.3	46.7	20
15	Availability of soap or water in toilets.	87.5	12.5	0	93.3	6.7	0

Table 2: 7-10 years

S. No	Questions	prior to Intervention			Post Intervention		
		Constantly %	Occasionally %	Not at all %	Constantly %	Occasionally %	Not at all %
1	Wash hands before meal	44	53.3	2.7	81.6	17.1	1.3
2	Wash hands after meal	45.3	53.4	1.3	81.6	18.4	0
3	Wash hands after defecation	82.7	17.3	0	100	0	0
4	Wash hands before sleep	25.3	53.3	21.4	94.7	5.3	0
5	Wash hands after utilizing local transportation	2.7	68	29.3	51.3	28.9	19.7
6	Wash hands after awoken	50.7	41.3	8	97.4	2.6	0
7	Wash hands after contacting animals	10.7	61.3	28	81.6	14.5	3.9
8	Wash hands only when dirty	82.7	13.3	4	97.4	2.6	0
9	Wash hands after sneezing, coughing or nose cleaning	9.3	65.3	25.4	59.2	32.9	7.9
10	Wash hands after touching debris/garbage	53.3	4	6.7	90.8	9.2	0
11	Wash hands before contacting ill person	1.3	16	82.7	30.3	36.8	32.9
12	Wash hands after contacting ill person	4	29.3	66.7	32.9	34.2	32.9
13	Always use soap for washing hands	73.3	26.7	0	65.8	34.2	0
14	Is towel available in toilets?	32	36	32	69.7	22.4	7.9
15	Availability of soap or water in toilets.	84	16	0	97.4	1.3	1.3

Table 3: 11-14 years

S. No	Questions	Prior to Intervention			Post Intervention		
		Constantly %	Occasionally %	Not at all %	Constantly %	Occasionally %	Not at all %
1	Wash hands before meal	52.3	34.1	13.6	75.6	24.4	0
2	Wash hands after meal	40.9	52.3	6.8	75.6	24.4	0
3	Wash hands after defecation	81.8	15.9	2.3	97.8	2.2	0
4	Wash hands before sleep	18.2	45.5	36.4	88.9	8.9	2.2
5	Wash hands after utilizing local transportation	4.5	52.3	43.2	62.2	26.7	11.1
6	Wash hands after awoken	56.8	38.6	4.5	97.8	2.2	0
7	Wash hands after contacting animals	22.7	50	27.3	91.1	6.7	2.2
8	Wash hands only when dirty	68.2	27.3	4.5	97.8	2.2	0
9	Wash hands after sneezing, coughing or nose cleaning	13.6	54.5	31.8	71.1	22.2	6.7
10	Wash hands after touching debris/garbage	54.5	34.1	11.4	91.1	8.9	0
11	Wash hands before contacting ill person	0	15.9	84.1	31.1	37.8	31.1
12	Wash hands after contacting ill person	6.8	36.4	56.8	31.1	37.8	31.1
13	Always use soap for washing hands	61.4	38.6	0	62.2	37.8	0
14	Is towel available in toilets?	31.8	38.6	29.5	57.8	26.7	15.6
15	Availability of soap or water in toilets.	88.6	11.4	0	100	0	0

4. Discussion

The outcomes of this study showed that prior to intervention, children of both orphanages practiced hand washing, before the meal (43.7%), after the meal (38.5%), after defecation (77%), before sleep (23.7%), after utilizing public transport (3%), after sneezing, coughing or nose blowing (11.9%), after contacting animals (14.8%), after touching debris or garbage (57%), and practiced hand washing with using soap (68%). The improvement were seen in post-intervention, before the meal (75.7%), after the meal (75.7%), after defecation (98%), before sleep (91.2%), after utilizing public transport (53%), after sneezing, coughing or nose blowing (85.3%), after contacting animals (60.3%), after touching debris or garbage (90%), and practiced hand washing with using soap (63%).

The findings of this study showed that in the pre-assessment 73% of children responded that there is a lack of towels in the toilet. While in post-assessment 43% of children responded that there is a lack of towels in the toilet. About four students, meanwhile, stated that there was no soap provided in the institution for hand washing [20]. In this study, prior to assessment about 80% of the children responded that there is sufficient water supply and soap in the toilets. While in the post-assessment all the children responded that there is sufficient water supply and soap in the toilets. All institutions had an adequate supply of water and basic facilities for washing hands [20].

In our study, results showed that children between 3 and 6 ages had lack of practice to wash hands such as before the meal only 18.8%, after meal 0%, after defecation 37.5%, before sleep 31.3%, after coughing or sneezing 18.8% and after contacting sick person 6.3% of the children wash their hands prior to assessment. While in post intervention their practice improved to wash their hands before meal 46.7%, after meal 46.7%, after defecation 86.7%, before sleep 80%, after coughing or sneezing 33.3% and after contacting sick person 26.7%.

The children between 7 and 10 ages practiced hand washing before the meal only 44%, after meal 45.3%, after defecation 82.7%, before sleep 25.3%, after coughing or sneezing 9.3% and after contacting sick person 4% of the children wash their hands prior to assessment. While in post intervention their practice improved to wash their hands before meal 81.6%, after meal 81.6%, after defecation 100%, before sleep 94.7%, after coughing or sneezing 59.2% and after contacting sick person 32.9%.

The children ranging from 11 to 14 ages had more practice of hand wash as compared to ages 3 to 6 and 7 to 10 years. Before the meal only 52.3%, after meal 40.9%, after defecation 81.8%, before sleep 18.2%, after coughing or sneezing 13.6% and after contacting sick person 6.8% of the children wash their hands prior to assessment. While in post intervention their practice improved to wash their hands before meal 75.6%, after meal 75.6%, after defecation 97.8%, before sleep 88.9%, after coughing or sneezing 71.1% and after contacting sick person 31.1%

Children ranging in age of 11 and 15 were more aware of the need of washing their hands than those children ranging in age of 7 and 10 [18]. Due to the wash sinks' remote position, the majority of children in both age groups skipped washing hands [18]. Urban residents demonstrated good hygiene habits, washing their hands before eating, after touching filthy objects, and after sneezing or coughing [20].

Our findings showed that hand washing steps followed by orphaned children in pre-intervention, only 88.1% rubbed the dorsal side of their hands, 62.2% rubbed the palm of their hands, 24.4% cleaned the fingertips or nails, 14.8% scrubbed between fingers, and 0% dried hands. While the improvement was seen in post-intervention 91.9% rubbed the dorsal side of their hands, 75.7% rubbed the palm of their hands, 43.4% cleaned the fingertips or nails, 35.3% scrubbed between fingers, and 27.2% dried their hands. Before instruction, 12.3% of the children correctly washed their hands. In the phase after the intervention, this number had risen to 44.3% [21].

5. Conclusions

To encourage children to wash their hands more frequently, educational interventions are helpful. This was the first research in Pakistan to compare hand washing habits prior to and post-intervention on orphan children in Sindh. According to the report's findings, children did not know how to properly wash their hands prior to intervention, but after being exposed to the education session, this behavior changed. The toilets at the SOS orphanage, Jamshoro were found to be without soap and a towel prior to the intervention. Children usually just use water for washing hands. And after washing their hands, nobody uses the towel to dry their hands. We recommend additional educational programs on hand

hygiene behavior that are most efficient, practical, and economical to be implemented at educational institutions and other orphan homes to enhance the children's cleanliness practices and general well-being.

Author Contributions:

Study Conducted By: Afsheen Tunio, Dr. Jamil Ahmed.

Funding: This study was funded by USPCASW Muet Jamshoro (Research grant)

Acknowledgments: The researchers wanted to acknowledge USPCAS-W for providing financial support; SOS and Dar ul Ehsas for providing technical support and US-Pakistan Center for Advance Studies in Water, Mehran University of Engineering and Technology for providing the platform to accomplish this research project.

Conflicts of Interest: The authors declare no conflict of interest.

Water Pollution and Wastewater Management

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Abstract

Water pollution is a serious threat to living entities on the earth planet, which has detrimental impacts on human health, agricultural, and aquatic life. The most hazardous class of Chemical water pollutants is POPs (Persistent organic pollutants), applied to control insects and unwanted weeds from an agricultural perspective. Worldwide, the most widely used POPS is Atrazine which is classified as an organochlorine-herbicide pesticide (OCPs), to kill unwanted weeds such as broadleaf weeds and Spanish needles. Atrazine has lethal impacts in 2 to 15 $\mu\text{L/L}$ doses on fish species like grass carp. The atrazine pesticide type S-triazine mainly caused endocrine disruption in pregnant women, infant's growth retardation, physiological, and physical disorders. Moreover, Atrazine inhibits the microalgae; that survive in aquatic water bodies to fulfill the nutritious requirements of aquatic life. For, the transition metal (Titanium dioxide) nanoparticles are highly sensitive to removing atrazine pesticides, because of their high porosity, large surface-to-volume ratio, smallest particle size, and high adsorption capacity. To check the effectiveness of TiO_2 NPs, the UV-Spectroscopy of synthesized TiO_2 Nanoparticles was determined in the absorption range of 300-700 nm, which reveals the strong absorption peak of UV-Visible spectroscopy to remove atrazine, POPs from real water sample. The Particle size and surface area of TiO_2 NPs was characterized through the X-ray Diffraction (XRD) technique in the most feasible range of 74 nm and 19.26 m^2/g . The overall efficiency of nanoparticles shows the highest adsorption level of atrazine on the surface of TiO_2 Nanoparticles. Therefore, the nanotechnology is a highly reliable, economically viable, and Eco-friendly technique to overcome the issue of persistent pollutants in water and to save aquatic life.

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Efficient Banana Peel-Based Bio-sorbent for Adsorptive Removal of Moxifloxacin

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Abstract

In this research, the adsorption of Moxifloxacin (MOXI) antibiotic on banana peel from aqueous solutions was studied. The adsorption of the MOXI using banana peel adsorbent was investigated under batch conditions. Characterization of grounded banana peel was done using FTIR, SEM and Zeta potential techniques. During adsorption batch experiment various parameters such as effect powdered banana peel dose, initial antibiotic concentration; contact time of adsorption and the agitation speed were optimized. It was observed that the maximum 93% with RSD 2.98% MOXI removal was achieved at 150 mg dose of banana peel at 45 min contact time and 20 ppm antibiotic concentration with 100 rpm shaking speed. The adsorption models were linearly well fitted to both Langmuir & Freundlich isotherm models and pseudo second order kinetic model. The results showed that maximum adsorption capacity calculated was 221.5983 mg/g whereas the constant value K_2 for kinetic pseudo-second order measured was 0.04751 for MOX at constant pH (pH 6) and room temperature. Hence, this study demonstrates and proves that banana peel could be an effective bio-adsorbent for the removal of the selected antibiotic from aqueous media.

Keywords: Banana Peel, Bio-adsorbent, Removal, Moxifloxacin

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Water Quality Status of Natural Springs and Supply Water Resources in City Bagh, AJ&K

Authors

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Abstract

Access to adequate and safe drinking water is a human right and its provision is the responsibility of state. This responsibility has been conferred through the Constitution of Islamic Republic of Pakistan, Vision 2025, National and Provincial drinking water Policies and International Commitments such as Sustainable Development Goals (SDGs). Drinking water is basic necessity for human survival and a highly important water resource. Drinking water is important to daily life and plays a vital role in the development of society. Its monitoring to assess its fitness for drinking is a first step towards its management. Pakistan Council of Research in Water Resources (PCRWR) with the collaboration of Islamic Relief Pakistan has conducted a water quality assessment survey of water supply resources of Bagh City AJ&K under the project Sustainable and Equitable Water Solutions (SEWA) in AJ&K, during the period of October-2020 to April-2021. 50 water sources were tested and out of these 26 were monitored in phase-I and 24 sources in Phase-II. The test results of all the samples showed that 84.62% sources were found unsafe in the year 2020, while follow up-water quality assessment of these water sources during 2021 declared that 58.33% were found unsafe for drinking due to prevalence of Bacteriological Contamination, and Turbidity. The Islamic Relief has improved the community safe water supply from 15.38% to 41.67% by the installation of filtration units on the unsafe water sources/contaminated springs water at Bagh City following the recommendations of PCRWR. The analytical result further showed that overall (66%) of the sources were found to be unsafe mainly due to Microbial Contamination (66%), Fecal Contamination (50%) and Turbidity (44%). Presence of fecal contamination represented by the E-coli in 25 water sources is important and requires immediate attention. These findings demand the due attention of implementing agencies to undertake appropriate remedial measures such as source protection, pollution control, water treatment, capacity enhancement of water supply professionals and mass awareness on value of springs and safe water. Springs in Bagh are a unique and invaluable natural resource. However, these are under constant threat due to degrading environment. A comprehensive understanding of the spring systems and monthly water quality monitoring of spring water will provide the basis for their protection and wise use.

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Water quality of filtered water in housing societies of Lahore and associated health risks

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Abstract

Safe drinking water is the basic human right and a prerequisite for healthy survival. With increasing population and anthropogenic activities, this natural resource is in danger. The situation is more alarming in developing countries where timely monitoring and maintenance is not being followed. The present study is based on the water quality monitoring of filtration plants installed in the second most populated city of Pakistan, Lahore. Around 100 drinking water samples were collected from the filtration plants installed in different localities of Lahore. Physico-chemical parameters, Arsenic and Microbiological (bacteriological) contaminants were analyzed using the standard procedures and multivariate indices. The health risks were estimated based on the results. Analytical water quality results of all the water filtration plants were compared with WHO and PSQCA standards for drinking water. The results of study showed that out of total 100 filtration plants, 6 % of filtration plants have shown prevalence of bacteriological contamination in the water being supplied. Arsenic concentration was found above permissible limits in 56 % of filtration plants (WHO guideline value is 10 ppb). Hazard index of arsenic was less than 1 in adults and children. Children are found more prone to health hazards of water contamination.

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Formaldehyde Removal from Medium Density Fibreboard Effluent through Electrocoagulation

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Abstract

A lot of water and chemicals are used by different industries for a variety of purposes, after the required product is made, the water is turned into wastewater which harms aquatic and human life. Therefore, it must be treated before being discharged into waterbodies. Different techniques are used to treat industrial effluents. Medium Density Fibreboard (MDF) board industrial effluent contains formaldehyde pollutant, which is mutagenic and carcinogenic. This study focuses on electrocoagulation treatment of Formaldehyde (FA) removal. The experimental setup is based on Aluminium electrodes, a DC power source, a 500 mL Pyrex glass beaker, and a magnetic stirrer. And all experiments were performed in batch mode. The effect of operating parameters such as Time (0-210 mins), Current (1-3 A), electrode distance (10-20 mm), and mixing speed (60-100 rpm) was conducted to get an optimized parameter for maximum removal of FA. The sludge sample analysis was conducted to resolve the issue of sludge generated from the EC reactor. A kinetic study was also carried out to check the mechanism of Electrocoagulation on the removal of FA. The best removal efficiency of FA was obtained at optimum 150 minutes, 2.5 A, 15 mm, and 80 rpm with 55.5%. The general parameters were also analyzed such as TDS of about 85% and pH varying to 7.5-8. The kinetic study resulted that the pseudo first order kinetic model is more suitable for the removal of Formaldehyde (FA) with a regression coefficient of 0.8332 and rate constant of 0.0003. The sludge sample was collected and dried at 150°C for 4 hours and then analysed for SEM-EDX (Scanning Electron Microscopy-Energy Dispersive X-ray spectroscopy), it was observed from this analysis that the SEM image of the sludge is seem likely to be a shiny particle and the EDX results in elements include N 40%, C 20%, O 32%, and Al 6%. The pollutants of real industrial effluent were efficiently removed by the EC method. A kinetic model pseudo first order is better fits for the EC process. The sludge analysis resulted that a further study may be conducted to highly use nitrogen nutrient-rich sludge for agricultural purposes.

Keywords: Medium density fibreboard, electrocoagulation, wastewater, formaldehyde.

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Removal of Indigo Carmine Dye Using Natural BioSorbent Prepared from Press Mud

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Abstract

One of the most emerging problem nowadays is the wastewater released from the industrial sector of Pakistan which is unfit for recreational purposes whereas textile industries are providing a major contribution in the economic sector of Pakistan but the wastewater released from it is highly toxic possessing various organic compounds. The theme of this study focuses on the removal of Indigo Carmine which is a toxic, hazardous and carcinogenic dye released from the denim textile industry by preparing a novel adsorbent from the waste material of sugar industry produced as a by-product of sugarcane juice extraction. The adsorbent was prepared by a chemical modification of HNO₃ (nitric acid) in order to enhance its adsorption capabilities. The surface property of prepared adsorbent was also characterized by Fourier Transform Infrared Spectrometry and Scanning Electron Microscopy which confirmed the presence of alkyl halides, amides, nitriles and alcohols and showed a morphological surface of the prepared adsorbent that helps in adsorption. Various parameters such as effect of adsorbent dosage, pH, temperature and concentration of the dye solution were optimized to check the efficiency of the prepared adsorbent. The adsorbent showed promising results at normal pH range (6.5), minimum dosage of adsorbent, higher temperatures and concentration with a maximum adsorption capacity of 138mg/g. The experimental data followed Langmuir isotherm with a good correlation ($R^2 = 0.97$). The thermodynamic study revealed the process to be spontaneous and endothermic in nature while the kinetic study proved pseudo second-order model fits the best. The fixed bed column analysis was also performed to achieve a breakthrough curve of the adsorbent obtained at 0.5 (C_t/C_0) and the experimental data showed Thomas model to be the most suitable fit with a good correlation of ($R^2 = 0.97$). Thus it could be concluded that press mud could be a good adsorbent for the treatment of Indigo Carmine dye and it is most suitable as it is economically feasible and cheap.

Keywords: Press mud, Adsorption, Wastewater, Dye, Indigo Carmine and Textile Industry

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Development of Indigenous Arsenic treatment unit for drinking water.

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Abstract

The purpose of this study was to development of Indigenous Arsenic treatment unit for drinking water samples. The water samples were collected from different sampling points of Tehsil Sakrand from installed hand pumps and tube wells. The Indigenous Arsenic treatment unit for drinking water was developed locally and comprises of three layers i-e Rusted iron nails activated carbon from milled rice husk with three layers, each with iron nails, activated carbon and milled rice husk from the top to bottom. The arsenic contaminated samples were introduced from top layer and treated samples collected from bottom of unit through tap valve. The arsenic contamination of the samples was checked before and after treatment with the help of arsenic measuring kit. The contact time of the samples through the beds of developed unit was around 30 minutes. The highest concentration of arsenic in groundwater samples was found 250 ppb taken from village Mir MuhammadKalhoro. No all the samples were successfully treated for arsenic contamination. It is concluded that the developed unit is a suitable and indigenous and effective for the treatment of arsenic contaminated samples up to 250 ppb concentrations.

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The profile of total dissolved solids and arsenic of groundwater, near River Ravi, Lahore, Pakistan

Habib Ur Rehman⁵⁹, Faakhar Raza⁶⁰ Shazia Ghaffar³⁶, Mujeeb Ur Rehman³⁷, Hifza Rasheed³⁶

Abstract

Urban areas under the influence of multi-industrial activities with arid and semi-arid environments witness the significant increase in environmental pollution especially in the water sector. In this study, total dissolved solids (TDS), pH and Arsenic (As) concentration were explored depth-wise from a drilled bore hole at main Raiwind Road, ThokarNiazBaig near River Ravi, Lahore. The concentration of the TDS profile was found poor at the upper ground level, while moderate and excellent at the higher depth level, indicating that top shallow aquifer containing high salts, was produced due to local inputs of residual effluents that are discharged into the Ravi river and, to some extent, from water evaporation. In the case of as, a minimum value of 0.59 ppb was found for arsenic in the shallow groundwater, whereas the arsenic value increased downwards, indicating a maximum increase of 18.78 ppb in deep groundwater. The variation in arsenic values are influenced by natural and as well as anthropogenic activities. The results of TDS and As concentration above World Health Organization (WHO) guideline values in some depth ranges can be harmful to human health.

Keywords: Arsenic; borehole; groundwater quality; total dissolved solids.

1. INTRODUCTION

Water is a precious and finite commodity on the globe and is a fundamental natural resource for sustaining life on the earth. Safe drinking water is a basic need for all human beings. Presently, millions of people worldwide are facing water shortage (Ayotte et al., 2016). Groundwater is the most common source of drinking water and generally unsafe for drinking due to industrial pollution, irrigation, and the use of agricultural pesticides, which are the main source of groundwater contamination. (Chakraborty et al., 2019)(Farooqi et al., 2009).

In Pakistan, most of the drinking water source is groundwater. There are various routes of groundwater extraction like open wells, springs, tube wells, injector pumps, hand pumps, and infiltration galleries and directly consumed by the public without any problem testing or treatment. The discharge of soluble salts from watersheds into water resources can increase soil salinity. A high concentration of salts presents a risk for the environment and also for agricultural aspects. (Dwivedi et al., 2015). Niaz et al, studied the electroconductivity (EC) of the shallow aquifer at 60-meter depth, which varied between 250 to 4500 $\mu\text{S}/\text{cm}$. On the other hand, the deep aquifer at 90–180-meter depth, EC varied between 250 and 1750 $\mu\text{S}/\text{cm}$, with a maximum frequency of approximately 500 $\mu\text{S}/\text{cm}$ (Niaz Ahmad, M.A., Muhammad Rafiq, Naveed Iqbal, 2016). It indicated that shallow aquifer is more saline, as compared to the deep aquifer. The unconfined aquifer of Lahore is highly vulnerable to contamination as the rapid mixing of shallow groundwater near the Ravi River (Mushtaq et al., 2018).

Groundwater and surface water contamination caused by sewage and industrial waste is a major health risk. Groundwater contamination causing various health risks such as typhoid, hepatitis, and other

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infections is common. (Iglesias-Martínez et al., 2018). As contaminated water is considered a hidden enemy of the living system. As present in groundwater, which comes from sediments, rocks, is the main culprit of poisoning due to its carcinogenic ability and causes cancer in the living system. (Lee et al., 2001)(Baig et al., 2009).

The quality of groundwater can affect due to the interaction between the rocks, the dissolution of soluble minerals and different types of anthropogenic activities such as the excessive use of domestic and industrial waste. (Ayandiran et al., 2018). As-contaminated groundwater in alluvial aquifers of the Indus river plain, Pakistan, is mainly caused by microbial reduction of sedimentary iron oxyhydroxides, driven by microbial oxidation of organic matter. (Nickson et al., 2005).

Once arsenic is released and its mobility could change depending on its speciation and valence state. The adsorption affinity is higher for As^{5+} and As^{3+} at acidic pH and alkaline pH conditions, respectively (Abiye and Bhattacharya, 2019). As is predominantly sorbed on Fe and Al oxide-hydroxide surfaces and mobilized under a high pH environment, including other ions (Litter et al., 2019). As co-precipitation with Fe(III) can only oxidize the arsenic, As(V), which is the predominant species (Ahmad et al., 2020). Studies found that hundreds of people, particularly children, have suffered crippling deformities mainly in the legs and spine with severe pain in the Manga Mandi area.

In another study, several people are unable to walk, and the villages of Pattoki, Kasur have been suffering from serious water-borne diseases, individual cases exposed by a high concentration of arsenic and fluoride. (Li et al., 2012) (Asrar Ahmad et al., 2013)(Rasool et al., 2016).

There are several factors that are altering the level of contamination, including chemical and physical parameters such as temperature variation and discoloration. It is mainly related to environmental changes and the use of chemicals such as an increase in the concentration of synthetic nutrients in an ecosystem. (Fontenot et al., 2013). Furthermore, the quality of groundwater was also changing due to the addition of environmental pollutants and contributed to human activities. (Kumar et al., 2016)(Riahi et al., 2018). In earlier studies, possible health problems, changes in water quality due to seasonal variations were observed in mixed waters of the Ravi and Chenab rivers, for different time intervals. (Sharma and Singh, 2016)(Adujo et al., 2018). A study found that around 729 tonnes / day of untreated waste is discharged into the Ravi river, and around 1810 cubic meters per second of domestic and industrial effluents are also discharged through pumping stations and drained into the Ravi river. (Shakir et al., 2013) Polluted water toxicity in the Ravi river stretch from Lahore siphon to Baloki headworks and related to effluent discharge tributaries, and severe arsenic problem is influencing healthy metabolic system.(Javed, 2005)(Soller et al., 2015). Additionally, hydrocarbon residues, organic and inorganic pollutants, moving along a fault, leaching and seepage are polluting the Lahore-Kasur groundwater near the Ravi river, which is an important source of drinking water.(Alizadeh et al., 2018)(Krüger et al., 2012).

The river Ravi originates in India and enters Punjab Pakistan with a total of 894 km in length. Different anthropogenic activities are changing the level of groundwater contamination such as municipal, paint, wood, pesticide and textile industries that use arsenic trisulfide, copper chromate, sodium arsenate, (Ahmad et al., 2020), and public wastes (Mehmood et al., 2014).

With the passage of time, the groundwater quality of the Ravi river and its surroundings deteriorates day by day due to domestic discharge and industrial waste falling into it. Based on these observations, the study area between the Hudiara drainage and the Ravi river was selected to explore the total dissolved solids, pH and As of the drilled bore hole depth. In this study, the water quality profile focused

on TDS and As to determine their concentration values at different depth ranges (upper to lower level) of a drilled bore hole. Water samples were collected from 15 to 120 meter during drilling borehole with 15-meter depth intervals.

MATERIAL AND METHODS

Methodology, sample collection and transportation

In the methodology, geophysical methods were used for bore hole along with the rotary well drilling. Here the bore hole drilling was carried out by using percussion rigs with a maximum depth of 120 meter. Groundwater samples (n= 8) were collected from a single drilled bore hole at different depth levels. The samples were stored in polythene plastic bottles (500ml), preserved using nitric acid, and sent to the laboratory within 4h for analysis. The water samples were analyzed in the Pakistan Council of Research in Water Resources (PCRWR) Lahore for three tests like total dissolved solids (TDS), pH, and arsenic (As)

Study area

The study area falls in between the Hudiara drain and the Ravi river, as shown in Figure 1. The drilled bore hole site located at Raiwind road near Thokar Niaz Baig, at Latitude 31°49'14", Longitude 74°23'85" and at 204m elevation.

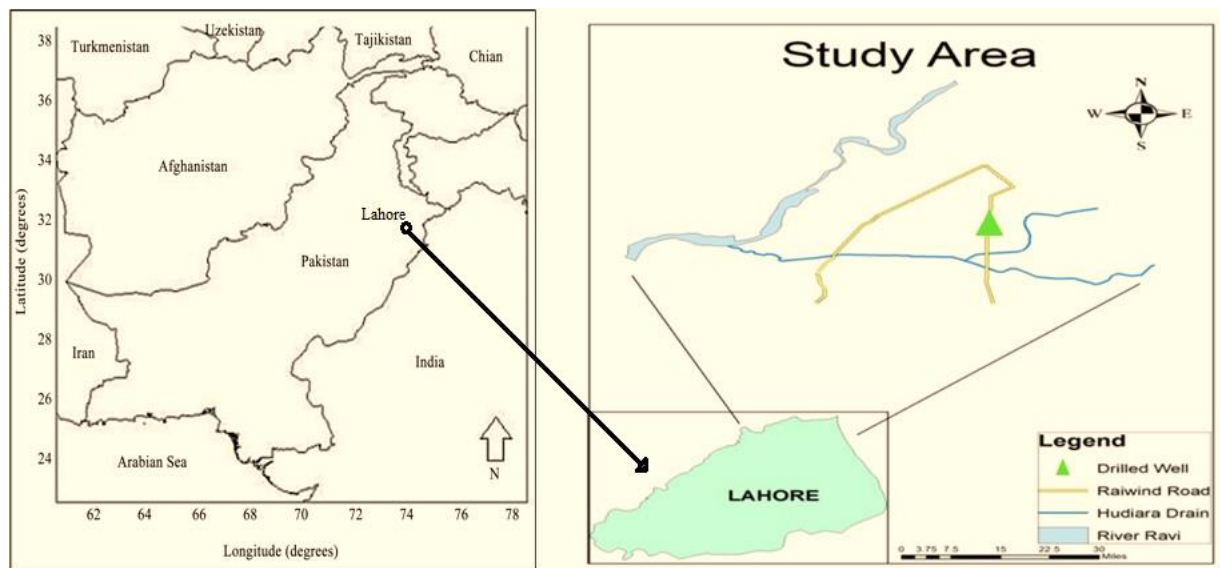


Fig.1
Study area of sampling from the drilled bore hole site.

1.1. Boring, sampling and analysis methods

This study was conducted using a boring system in a marked location (Fig.1) to target the shallow, intermediate, and deep aquifers. The boring was done up to a depth of 120 m and based on rotary reverse-circulation drilling (locally called the donkey method). Sampling was carried out following a similar procedure mentioned in the literature. Electrical conductivity (EC) and pH were measured using the portable field meters. All samples were filtered during collection using 0.45µm sartorius single-use membrane filters. Samples collected in polyethylene bottles were acidified with merck super-pure HNO₃, before arsenic analysis. The pH and TDS were analyzed without acid preservation. To maintain

the accuracy and precision of the results, all the samples were analyzed three times, and average results are presented in this work with a standard deviation of below 10%.

Table 1

Detail of

instrument used for the measurement of different parameters.

15. Parameters	16. Instrument detail
17. pH	18. pH meter, Model 970, Jenway
19. TDS	20. EC meter, Model HI991301, Italy
21. Arsenic	22. Atomic adsorption spectrophotometer, Varian 6.0 Analytikjena

2. RESULTS AND DISCUSSION

2.1. Geological and hydrological setting of the study area

Pakistan is characterized by the flat-lying Indus plains in the east, the Himalayas, the Karakoram and Hindu Kush mountains in the north, hilly area in the northwest and the Baluchistan plateau in the west. The climate is semi-arid to arid, except for the temperate in the northwest. Punjab is made up of up to 300 m of quaternary alluvial deposits and low organic permeable soil. Unconsolidated alluvial deposits of quaternary age cover the aquifer systems under Lahore and Kasur (current research area). The unconfined aquifer consists of alluvial and alluvial sand, with an average thickness of 400 meter. These sediments consist of fine to medium sand, silt, and clay, with different proportions of quartz, muscovite, biotite, chlorite, and heavy minerals. However, aquifers are heterogeneous due to the presence of alluvial sediments and regarded as high transmissivity (Mushtaq et al., 2018).

Hydro

geologically, the aquifer, of the study area is part of the large Bari Doab, which is bounded by the Sutlej and Bias rivers in the south-east and the Ravi river in the northwest. Rachna and Bari Doabs are part of the vast alluvial plain formed by the river Indus and its tributaries. The primary sources of aquifer recharge include rainfall and the Ravi river and irrigation tributaries flowing through the study area (Mushtaq et al., 2018).

Hydrological conceptual model

The aquifer less than 60 m depth was considered as the shallow aquifer, where as up to 120 m depth is unconfined (S. Haydar, H.H., O. Nadeem, G. Hussain, Jalees, 2014). The bore hole lies were within the unconfined aquifer. The unconfined aquifer consists of alluvial and alluvial sand, with an average thickness of 400 m. A simplified hydrogeological conceptual model of different depth level and bore hole location is shown (Figure 2).

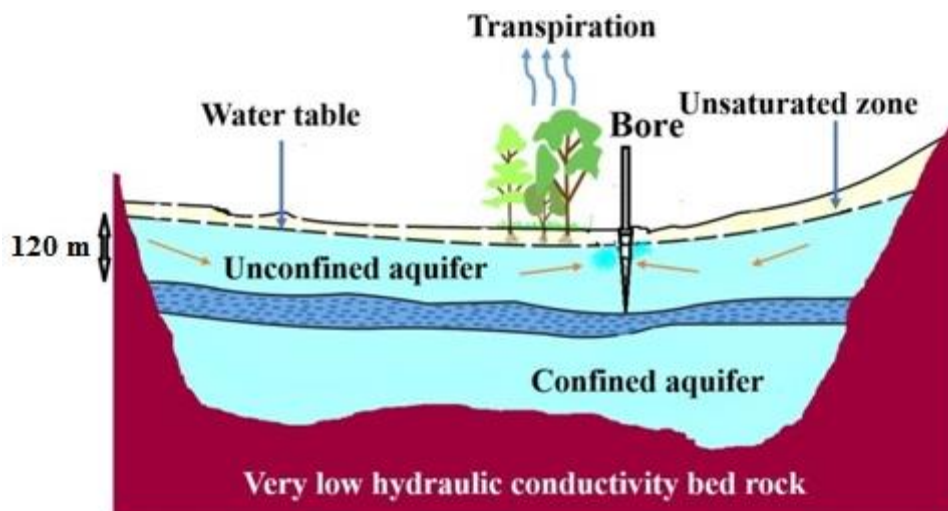


Fig. 2 Hydrogeological conceptual model.

These sediments of this model consist of fine to medium sand, silt, and clay, with different proportions of quartz, muscovite, biotite, chlorite, and heavy minerals. The aquifer gets significant recharge from the river Ravi. (Niaz Ahmad, M.A., Muhammad Rafiq, Naveed Iqbal, 2016).

Table 2 The pH, TDS, and As results obtained at different depth levels along with WHO permissible limits.

		25. pH	26. TDS (ppm)	27. As (ppb)
23. Sample code	24. Depth (meters)	28. Permissible limit	30. Permissible limit	32. Permissible limit
		29. 6.5-8.5 (WHO)	31. 1000 (WHO)	33. 10 (WHO)
34. S-1	35. 15	36. 7.76	37. 1525	38. 7.70
39. S -2	40. 30	41. 7.55	42. 1580	43. 3.96
44. S -3	45. 45	46. 7.46	47. 1638	48. 0.59
49. S -4	50. 60	51. 7.52	52. 1266	53. 1.50
54. S -5	55. 75	56. 7.58	57. 1172	58. 4.09
59. S -6	60. 90	61. 7.74	62. 700	63. 11.16
64. S -7	65. 105	66. 7.76	67. 531	68. 15.1
69. S -8	70. 120	71. 7.88	72. 419	73. 18.78

ppm: Parts per million, ppb: Parts per billion, WHO: World Health Organization.

2.2. Distribution of total dissolved solids, pH and arsenic in groundwater

Table 2

shows the results obtained for different groundwater parameters at different depth levels along with the permissible limit for each parameter. At 15-75 m has the maximum value of TDS (1638 ppm), at 75-90 m (TDS=1172 ppm), and at 105-120 m, the minimum amount is 419 ppm, and the quality of groundwater found poor, moderate and excellent, respectively. However, in the case of arsenic results varies at the top 7.7 ppb, at 60-75 m with 11.16 ppb, with increasing value as going downwards of 18.78ppb at 120 m (Table 2). The arsenic results showed that the toxicity level is increasing depthwise. There are considerably fewer health risks due to exposure to low concentrations, including the concentration within WHO guidelines for As in drinking water (< 10 ppb). Although, some commercial

companies are making efforts to reduce As in drinking water to below 1.0 ppb to avoid toxic effect on consumer health (Ahmad et al., 2020).

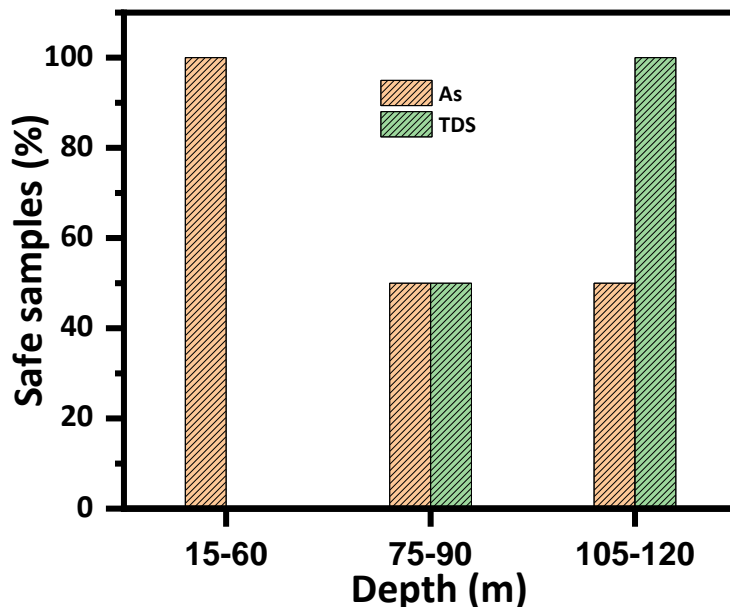


Fig.3 Percentage of safe samples based on depth for As and TDS.

Fig. 3 shows the percentage variation of safe samples based on depth. The results revealed that the elevated TDS concentration at upper depth is due to the high saturation of salts, widespread waterlogging from river Ravi while in the profound arsenic increases due to geochemistry, weathering of rocks. The main reason is the high TDS and As concentration is mainly related to the Hudiara drain all over year. The continuous domestic and industrial waste water discharges from different catchments of Lahore and finally falls into the river Ravi.

The %age of safe samples is presented in figure 3. The total dissolved solids (TDS) and arsenic concentrations are above the WHO guideline values at some depth intervals. In 2010, a research was conducted in the study area, and results concluded that the groundwater was predominantly of Na-Cl type, with associated minor hydro-geochemical facies to be Na-HCO₃, Na-Ca-HCO₃, and Ca-Mg-Cl. In this study, the results of the collected sample indicated a significant variation in TDS and arsenic concentration throughout the depth of the bore hole. The TDS and arsenic values showed variations as shown in figure 4.

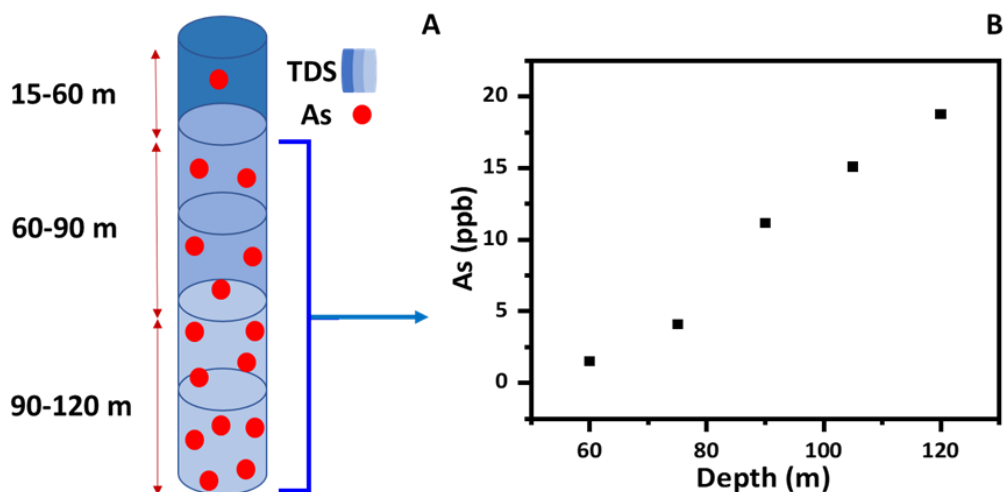


Fig. 4. (A) TDS and Arsenic variation depthwise; (B) arsenic values with depth.

Evaluation of Arsenic from top to lower shallow aquifer

The As release mechanisms in aquifer rock or sediment are linked to the extent of As contamination in groundwater systems. Arsenic was released to groundwater during the microbial mediated reductive dissolution of ferric hydroxides found in buried river-borne sediments (Herath et al., 2016).

In our study, water samples collected from top shallow groundwater at a depth of 15 m have arsenic value 7.7ppb, which was likely to be happened due to the leaching process of industrial wastes along with arsenical toxic chemicals from soils to groundwater. At this shallow part of the bore hole, the arsenic is present due to oxidizing conditions and, to some extent, by evaporative enrichment process. Similarly, the arsenic concentration seems to increase with depth, and differing geochemical signatures were seen in Thal Doab aquifer (District Muzaffargarh, Punjab), suggesting that As concentrations in groundwater may be governed by different processes (Naseem and McArthur, 2018). The same results were obtained by Farooqi et al, in her study, the percentage of high values of arsenic correlates very strongly with soil pH ($R = 0.977$), which is consistently elevated throughout the Indus plain. This implies pH-induced desorption for a site near Lahore, Punjab (Farooqi et al., 2009)(Podgorski et al., 2017). Aridity is also well correlated with high arsenic values ($R = -0.779$), which is consistent with the process of evaporative concentration, as suggested for Mailsi, Punjab (Rasool et al., 2016).The evaporative concentration of dissolved materials can produce elevated As in groundwater (Bhattacharya et al., 2006). In these systems, evaporation enhances the concentrations of all ions in residual waters, a process likely to happen in regions where the water table is very close to the surface and affected by evaporation (Nickson et al., 2005).

The values for $\delta^{18}O$ and δ^2H in groundwater varied between -9.14 to -5.51‰, and -56.57 to -39.5‰ respectively, and suggests the meteoric origin of the groundwater with some evaporative loss. This effect could be partly responsible for elevated levels of pH and salinity in groundwater. Based on the geochemical and isotopic composition of groundwater desorption of arsenic from metal surfaces under alkaline environment might be the factor causing arsenic enrichment in the study area (Mushtaq et al., 2018).

In the central shallow aquifer at a depth of 30-60 m, the arsenic values were found 3.96 to 1.50 ppb, which decreased from top 7.7 to 1.5 ppb. The arsenic values determined low at these depth intervals because of the sorption of As onto the sediments. In the same way, Nickson also studied low arsenic in

well water of district Muzaffargarh (Nickson et al., 2005). They described the sorption of As onto aquifer sediments during recharge and groundwater flow. In oxic recharge water, the As will be present as As(V), which sorbs firmly to hydrated ferric oxide and a phase ubiquitous in alluvial aquifers (Dixit and Hering, 2003).

The arsenic concentration increased from central to lower or deep shallow aquifer as determined 18.78 ppb at a depth of 120 m. In similarity, the pH of the collected samples was also increased from central to deep aquifer as 7.46 to 7.88, respectively. The arsenic level increases from low alkaline to higher alkaline (pH > 7.4) (Albanese et al., 2018). Under the influence of high alkaline water and high pH, results showed that As is released by oxidative dissolution. In earlier studies, pH was determined in the range of 7.3 to 8.8, and Eh was rather high 162 (between +113 and +402 mV), indicating mostly oxidizing nature of the aquifers. The significant correlation between arsenic and pH was reported ($r^2 = 0.56$) near the river Ravi (Mushtaq et al., 2018). The increase in pH (>8.5) is due to weathering of rocks (particularly silicate weathering) and associated cation-exchange reactions, which cause the desorption of arsenic from mineral surfaces (Kim et al., 2009). In current study area, the variations in arsenic concentration were determined by Mushtaq et al., with changing hydro-geochemistry, and Na-Cl and Na-HCO₃ were found to be associated with arsenic concentrations (Mushtaq et al., 2018). The relationship of TDS and arsenic with depth, as shown in figure 5 (A, B) while arsenic with TDS and arsenic with pH was shown in figure 5 (C, D), respectively.

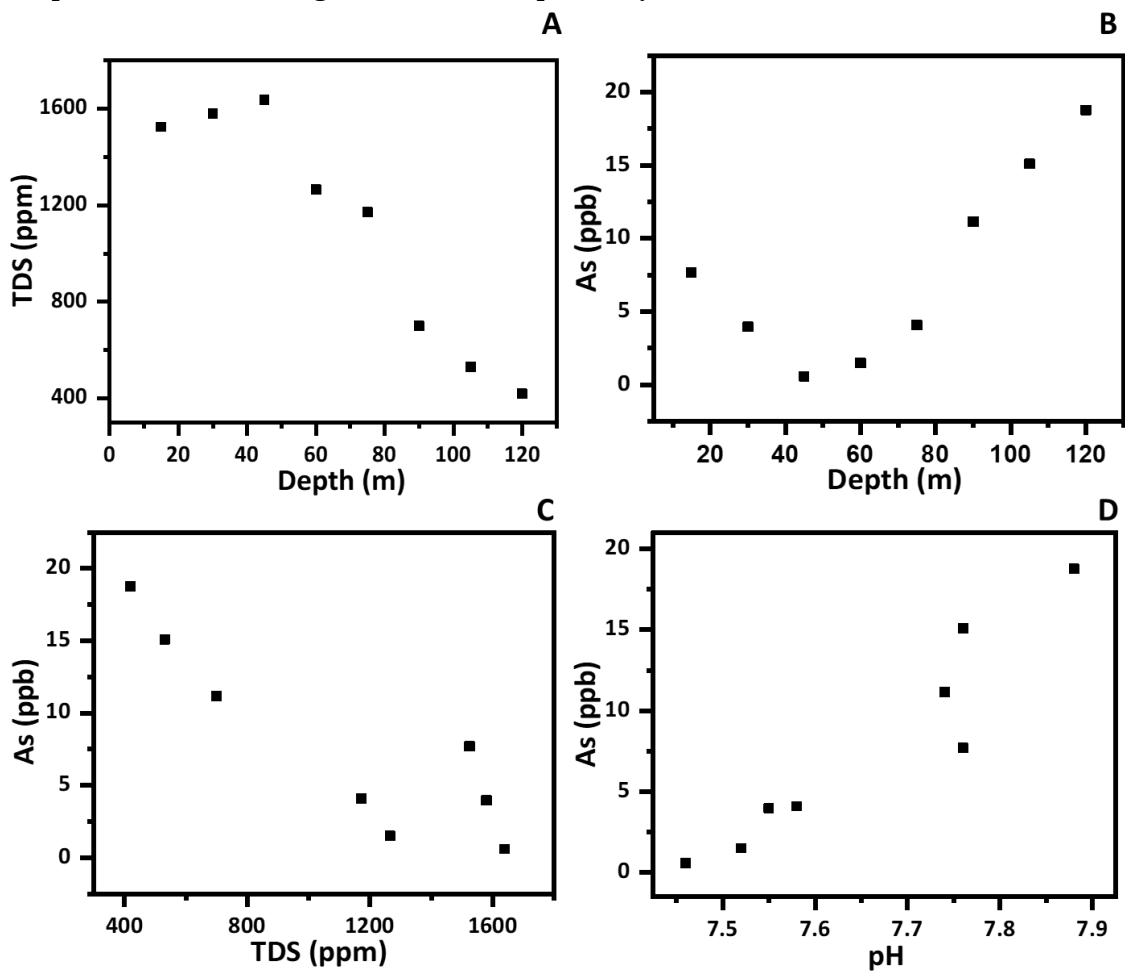


Fig. 5.

TDS values decreasing continuously with respect to depth (A); total arsenic concentrations (ppb) increasing depth-wise (B); Correlation of TDS and As (C); Correlation of pH and As (D).

The application of stable water isotopes has been considered to be a powerful tool for a better understanding of subsurface hydrology (Bhattacharya et al., 2019). In the alluvial plains of India, various studies have been carried out to understand geochemical behavior and recharge conditions. With the increasing well depth enrichment was observed in $\delta^{18}\text{O}$ and $\delta^2\text{H}$ and is reduced (enriched heavier isotopes $\delta^{18}\text{O}$ and $\delta^2\text{H}$) light isotopes were reduced with the increase of well depth, that further explains the role of evaporation in the groundwater recharge system (Kumar et al., 2018).

In summary, the results obtained and the studies previously reported from the study area, supported this research work for the evaluation of TDS and the variation of arsenic in depth and indicating that underground activities throughout the depth are influencing by natural and as well as anthropogenic activities. The quality of the water deteriorates along the river, which can affect the overall quality of the aquifer.

CONCLUSIONS

In this study, the concentration of TDS and As from the upper part to the lower shallow aquifer was determined. At the top, the TDS values were found high as 1638 ppm and declining down as 419 ppm. The results showed that the TDS quality profile was poor at the top while excellent at deep ground level. This indicated that the upper shallow aquifer is more saline compared to the deep aquifer and in the upper part, the high concentration of TDS that exceeds the limits of the WHO, is due to the local inflows of residual effluents that are discharged into the Ravi river and to some extent, to the evaporation of the water (Mushtaq et al., 2018).

The As values from the upper to the lower level fluctuated and found a maximum of 18.78 ppb at deep groundwater. The As values were found rising in some depth ranges and the pH values also rising, indicating that As and pH strongly correlate with each other. The As results appeared to be dominated by high pH, the increase in alkaline in depth, is the result of geochemical oxidative dissolution. (Farooqi et al., 2009) (Abiye and Bhattacharya, 2019).

In conclusion, the obtained results showed that groundwater quality is influenced by natural and as well as anthropogenic activities along the river. The industrial waste effluents falling into river Ravi, has major effect on the deterioration of groundwater quality. This study provides the information for the government and private agencies to take prevention measures, make a policy to check and control the deterioration of groundwater and protect the health of local community. In addition, this study should further explore groundwater quality, including heavy metals and chemical tests to measure the extensive contamination.

Production of Organic Fertilizer by Recycling of Sugar Industry Waste

Anjum, RasoolBux Mahar*, Tanveer Ahmed⁶¹

Abstract

The sugar industries of Pakistan play a fundamental role in the development of the socio-economic sectors of the country, in Sindh, out of 18, seven sugar industries with distilleries are in operation. The anaerobic digestion of spent wash (wastewater from the distillery industry) produces biomethanated spent wash, which is enriched in nutrients but also causes a number of cumbersome, complex issues like turbidity in the water and impairment of the biological activity of the water making it unsafe to dispose of directly in the environment. Furthermore, press mud is a nutrient- and organic-rich by product of sugar mills that poses a significant disposal challenge, while direct application to soil may accelerate the growth of some pathogenic fungi. In this study, the biomethane spent wash was treated using an evaporation technique before being combined with the press mud in a variety of ratios to produce organic fertilizer. A bubble column evaporator is used for the post-treatment of biomethanated spent wash in order to increase the nutrient content for the production of fertilizer. Furthermore, the characterization results showed that biomethanated spent wash still posed significant chemical oxygen demand, biochemical oxygen demand, high quantities of total solids, and high content of potassium, similarly after evaporation nutrient concentration is increased. It has been shown that developed organic fertilizer has a 10% potassium content and is 4% enriched in nitrogen compared to other elements. The best ratios (biomethanated spent wash: press mud) for producing organic fertilizer were found to be 1, and 3. It has been noted that as the ratio increases, the concentration of NPK in organic fertilizer increases. Therefore, the production of organic fertilizer from waste results in zero effluent discharge and might be used as an alternative to synthetic fertilizers because it is cost-effective and improves soil conditions.

Keywords: Press mud, Organic Fertilizer, Biomethanated spent wash and Evaporation.

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Effects Of Industrial Effluents on Physico-Chemical and Nutritional Parameters of Maize

Basmina, Gulfan Ullah, Amana Khatoon, Ghazala Nawaz⁶².

Abstract

Sugar industry is a very important agro-based industry and it discharges large amount of effluents into water bodies to create high pollution in water bodies which affects the plants and other living organisms. In the present research study, numbers of roots were calculated. The results indicated that the increase in sugar mill effluents concentration caused a marked increase in hydrogen peroxide (H₂O₂) contents, activities of antioxidant enzymes such as superoxide dismutase (SOD), catalase (CAT), peroxidase (POD) and ascorbate peroxidase (APX) in maize. The impact of different concentrations (control, 5, 10, 25, 50, and 100%) of Chashma sugar mill effluent on seed germination, physic-chemical and nutritional parameters of maize was studied. The morphological parameters such as germination percentage, shoot length, root length, fresh weight and dry weight of seedlings, number of leaves and number of roots in maize. The increase in anti-oxidative potential enabled maize plants to withstand sugar mill effluents induced oxidative stress in maize. Results also showed that the morphological, physiological, physic-chemical ad nutritional parameters gradually decreased with increasing concentration of sugar mill effluents.

Key words: Effluents, oxidative stress, Chashma sugar mill, Catalase, Water bodies.

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Optimization of N: P & Mg: P ratio for struvite recovery from molasses-based distillery spent wash

Aliza Arain and Naveed Ahmed Qambrani⁶³

Abstract

Distillery spent wash is one of the most serious environmental problem because it is the undesirable residual liquid waste produced during the alcohol production process. Phosphorus is a precious resource, and at present rates of consumption, the world's phosphate rock stocks will soon be exhausted. In this study, a chemical experimental process is used to optimize the recovery of ammonia and phosphorus using struvite precipitation from synthetic effluent from distillery spent wash. The following study was executed to assess the effect of, different molar ratio on precipitation of struvite. The molar ratio of $\text{NH}_4:\text{PO}_4$ and Mg: P was optimized for the current study. The pH was raised up to 9.0 and the results showed at $\text{NH}_4:\text{PO}_4$ 1:1, the $\text{PO}_4\text{-P}$ recovery from synthetic wastewater is 88.8%, 2:1 shows increasing up to 92%, 3:1 shows quickly increasing 98.5%, and at 4:1, 5:1, showing decreasing at 94% and 92.5%, respectively. The Mg: P molar ratio is another important factor in struvite precipitation. The results indicate that raising the Mg: P ratio to 1:1 increased $\text{PO}_4\text{-P}$ recovery by 90%, increasing the Mg: P ratio further to 1.25:1, 1.5:1, 1.75:1, and 2:1 results in $\text{PO}_4\text{-P}$ recovery of 94.5%, 96.5%, 92.5%, and 92%, respectively. The greatest recovery was found at $\text{NH}_4:\text{PO}_4$ 3:1 98.5% and Mg: P 1.5:1 96.5%. Regarding phosphate recovery, the experimental results were fairly consistent. The results of this study have demonstrated that recovering phosphorus and ammonia by struvite precipitation from distillery wastewater is an environmentally friendly and novel way to treat wastewater that is nutrient-rich economically. The recovered struvite may also be utilized as a slow-release fertilizer for plants.

Key words: Struvite, Magnesium ammonium phosphate, Fertilizer, Phosphorus recovery

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A Critical Review of Textile Dye Wastewater Treatment Processes

Muhammad DanielSaeed Pirzada⁶⁴

Abstract

Textile sector has been identified as one of the major industrial sources of water pollution in Pakistan, posing a high level threat human health and environment of water body systems. Being water-intensive, textile production processes generate high volumes of effluents carrying harmful chemicals. The dye wastewater badly impacts aquatic life and photosynthetic function in plant. This consequently requires appropriate effluent treatment system before releasing these streams in the environment and water body systems. The fact, that Pakistan is amongst the most overpopulated and thirsty country of the world adds to the gravity of the crisis. This demands an effective wastewater management in the textile sector of the country. This paper summarizes the processes that generate textile wastewater streams and the typical composition of these streams. The most commonly practiced water treatment processes have been reviewed and compared based on their effectiveness and efficiency. The R&D areas of high potential have also been highlighted.

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Combined Adsorption Distillation Technique to Treat RO Membrane Reject Water

Tanveer Ahmed Gadhi, Tayyab Ahmed Qureshi, Sikandar Lodhi, Sanam Bhatti, Rasool Bux Mahar⁶⁵

Abstract

Reverse osmosis membrane reject-water (RORW) is high in Total Dissolved Solid (TDS) and is an environmental concern if not treated correctly. Most of RORW ends up in rivers, increasing TDS in water, increasing salinity and affecting aquatic life. This research proposes to treat RO Reject Wastewater via Combined Adsorption Distillation (CAD) Technique. This technique has many benefits, and the RORW with high TDS could be separated from a concentrated load of minerals, elements, and dissolved solids via evaporation and adsorption, while the recovered distillate could be re-used as freshwater in textile processing producing fresh water and adsorption of salts for safe disposal. Distillation removes most of the organic components and kills bacterial contamination. Meanwhile, the adsorbent captures the Total dissolved solids (TDS) and organic load (OL) during distillation. Two different composite adsorbent media (CAM) were used C₁, comprised of (20% Activated Carbon, 30% River Sand and 50% Clay), and C₂, comprised of (20% Activated Carbon, 30% Sand, 50% Brick Clay). In this study, RO reject water with TDS of 6700mg/L was acquired from Al-Rahim Textile Mills (ART). A lab-based and pilot scale study was conducted to analyze the effect of Adsorptive Distillation. Initially, a lab-scale distillation set-up was used, with the treatment of one liter of the collected RORW heated at different temperatures (105, 110, and 120°C), time (2hr, 2.5hr, 3hr) and dosage (2g/l, 5g/l and 10g/l) of C₁ and C₂. The maximum TDS removal (96%) was recorded at 110°C. By varying dosages of CAM (2g/l, 5g/l and 10g/l). The results indicated that at 10g/L dosage of C₁ and C₂ at lab scale resulted in TDS removal of 96 and 97%. After optimizing the lab-scale conditions, a pilot-scale CAD unit of 10 liters' capacity was designed and fabricated (including an adsorption-distillation bed, heating coils, condenser and water inlet and outlet fitting). The fabricated pilot-scale unit was operated at USPCASW, MUET, Jamshoro, and TDS removal efficiency of 99% was achieved. Meanwhile, adding adsorbent media increased the salts removal efficiency, and the CAM was re-used after backwashing. This showed that adsorption distillation could treat RORW and highlight the future research area for RO-reject water treatment.

Keywords:

Adsorptive Distillation, Adsorption, Composite Adsorbent, TDS Removal, Saline water Treatment, Reverse Osmosis Water Treatment

1. Introduction

The reverse osmosis (RO) method is commonly used to purify water with high levels of salt, but it produces a large volume (38%) of reject water with high levels of total dissolved salts (TDS) and other contaminants such as toxic metals and organic pollutants (Lee, Jeon et al. 2019). This reject water can itself be an environmental issue (Panagopoulos, Haralambous et al. 2019). While RO technology is often used in industries like textiles, chemicals, and food production to obtain clean water, it is costly and can have negative impacts on the environment due to the high volume of reject water that is often released into bodies of water without further treatment, leading to increased TDS, metals, and other contaminants resulting in contamination of water bodies (Rilwani and Agbanure 2010). Freshwater consumption is high in certain industries, such as textiles, where washing and dyeing processes require

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large amounts of fresh water (Yaseen and Scholz 2019). This results in production of high quantities of toxic and colored wastewater and most conventional treatment approaches do not provide acceptable solutions for the treatment of rejected water (Panagopoulos et al. 2019).

In addition, the various technologies are designed for desalination, such as solar distillation, evaporation, membrane technology and electro dialysis. All these treatment options require high capital cost, and operating costs. Distillation technology currently achieved a great attention for the treatment of reject water. Distillation of reject water typically removes most of the dissolved salts and toxic metals. In addition, the boiling process kills biological contaminants, and organic compounds that boil at temperatures greater than the boiling point of water also some pesticides and herbicides can be effectively removed from the water via distillation (Dvorak, Environmental, and Specialist 2014). Organic compounds that boil at temperatures lower than the boiling point of water (ex., benzene and toluene) will be vaporized as volatiles from the water. All treatment methods have limitations, and often a combination of treatment processes is required to treat the water effectively (Weber-Scannell and Duffy 2007). There is a need of effective and feasible treatment solution to overcome such issues by considering technological refinement, minimum capital cost, and negligible environmental impacts.

For the current study reject water from the textile industry (TI) was selected, and a novel technique combined adsorption distillation (CAD) technique was adopted. Initially, the reject water was characterized for physico-chemical parameters such as pH, TDS, EC, Hardness, chloride, and

selected metals such as calcium, and magnesium. A lab-scale distillation set-up was configured and used to separate the distillate from concentrated salts, minerals, and elements. In addition, for achieving the maximum efficiency, the parameters were optimized from lab-scale set-up and based on the analysis, the 60 liters capacity was designed and fabricated. The fabricated pilot-scale unit was operated at textile industry facilitated using the boiler waste heat for energy.

Materials and Methodology

Materials and method

All the chemicals used for current study were purchased from Sigma Aldrich. Sand and Brick Clay was collected from Jamshoro; sieved and washed several times to be used as adsorption media. Meanwhile, commercial Biochar synthesized from agriculture waste was purchased from the local market.

RO rejected water collection

The RO membranes rejected/brackish water of TDS 14898 mg/L was collected from Al-Rahim textile industry in bulk quantity and transported to the laboratory for further analysis and experiments.

Analysis and characterization of rejected water

The experiment were performed at the pilot-scale lab USPCAS-W. Initially, the Textile industry rejected water was characterized for TDS (Hanna 98911), Total hardness (Titration method), and selected metals such as calcium, magnesium, sodium (ICP-MS, Perken Elmer) and chloride (Argentometric method) through the standard method (APHA, Greenberg, and Eaton 2005). For treated water, the distillation rate and energy consumption was also recorded.

Batch and Pilot-scale experimental design

A small lab-scale experimental set up was designed as shown in Figure 1. Around 1 liter of the collected rejected water sample was analyzed at different temperatures ranges such as 105, 110, and 120°C using a fixed absorbing media dose containing (20% Activated Carbon, 30% Sand, 50% Brick Clay). After achieving the maximum TDS removal at a particular temperature, the doses of adsorbent

media were varied in the ranges from (2, 5 and 10 g/L). Based on the lab-scale setup's optimized conditions, a pilot scale setup of 10 liter capacity was designed and operated.

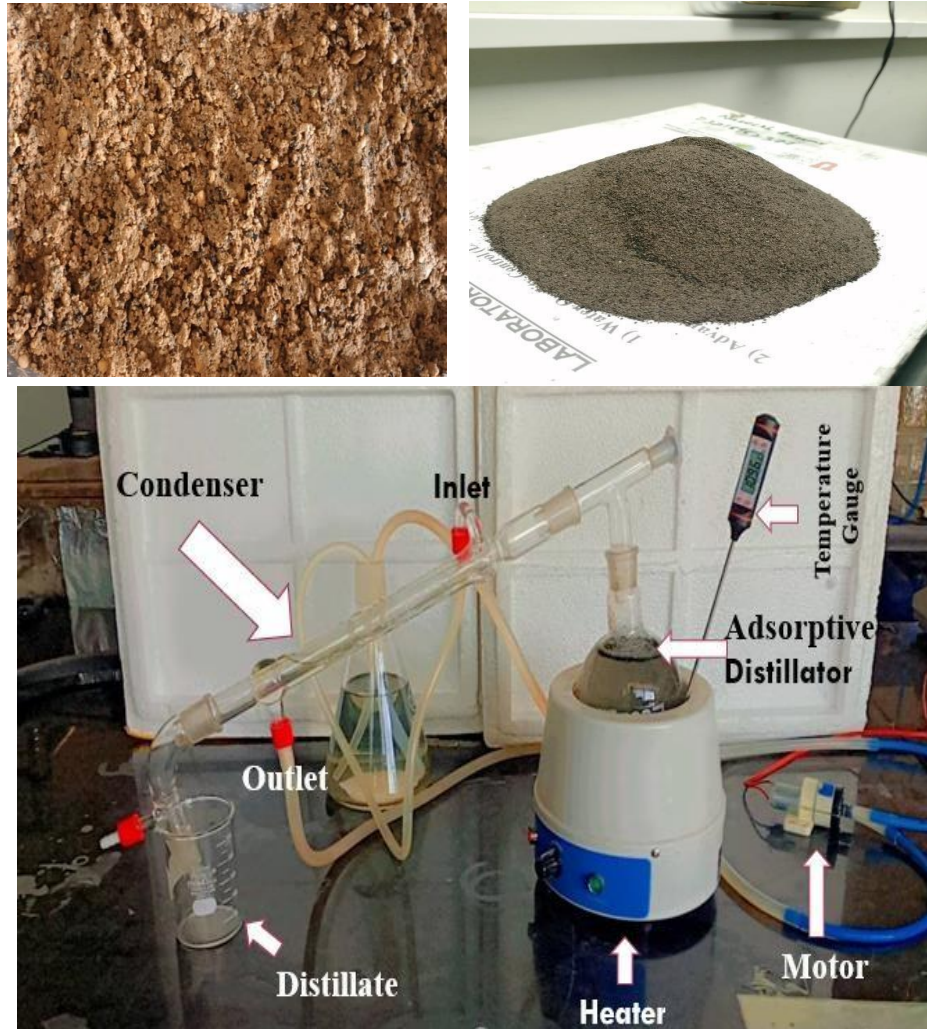


Fig: 1. (a-b) Adsorption media (c) Lab scale distillation set-up

Results and Discussion

Analysis of rejected water

The collected RO membrane rejected water was characterized and analyzed in Table 1. The effect of the temperature and absorbent was studied from the lab-scale distillation set-up. The results showed that sodium concentration (4112 mg/l) was recorded higher than other metals along with a higher removal efficiency around (99%) than other metals. Also, the TDS removal was higher as shown in Table 1.

Table. 1: Water quality analysis of Brackish and Treated/Distillate water

Parameter	Unit	Rejected water	Treated water
pH	-----	8.12	7.1
EC	uS/cm	16272	310
TDS	mg/L	6700	189
Turbidity	NTU	0.31	0
Sodium	mg/l	4112	49.4
Calcium	mg/l	412	19
Magnesium	mg/l	79	41

Effect of distillation temperature

To investigate the effect of temperature on distillation rate and TDS removal of the one liter of RO membrane rejected water was heated at different temperature ranges from 105, 110, and 120°C throughout at constant adsorbent dosage (2g/l). At different time intervals (3h, 2.5h, and 3h), the distillate samples was collected and TDS removal was observed and recorded 320, 405, and 620 mg/l, respectively. The results showed that an increase in the temperature decreases the TDS removal because by increasing the temperature, the evaporation rate was higher and carried the salts in the distillate sample.

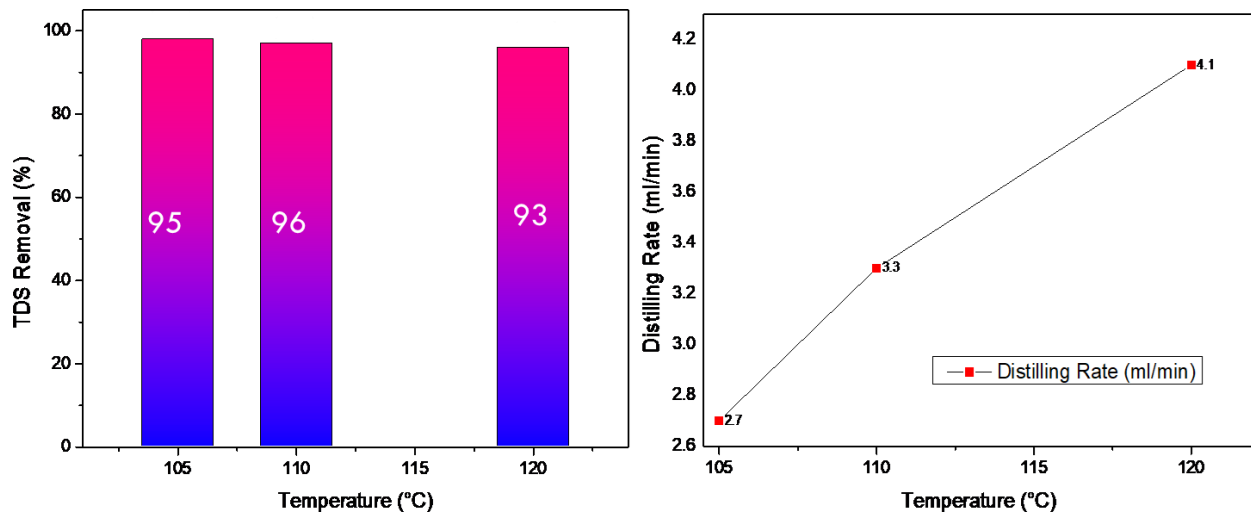


Fig: 2. (a) TDS removal (b) Distilling rate at different temperature

However, through the solar distillation technique, the higher the TDS and chloride removal was achieved (Said et al. 2021) (Hoque, Abir, and Paul Shourov 2019). But due to the low temperature and limited energy source, continuous distilled water production is not possible and depends on the various efficiency factor (Poblete, Salihoglu, and Kamil Salihoglu 2016).



Fig: 3. Contaminants removal efficiency before and after distillation

Furthermore, the distillation rate (3.1 ml/min) was recorded higher at 120°C as shown in fig: 2 (b). The Maximum TDS removal at the temperature 105°C was higher than the other temperature ranges. Table 1 shows the results obtained at three different temperatures.

Effect of Adsorbent

To distinguish and understand the mechanism of distillation and adsorption, the TDS removal was studied at different doses (2g/l, 5g/l and 10g/l) at constant temperature 110°C. The maximum TDS removal was recorded and investigated at 2g/l dose, 118 mg/l followed by 240 mg/l at 5 g/l as shown in fig: 3. Moreover, It shows that the efficacy of TDS removal was reduced due to increasing the temperature.

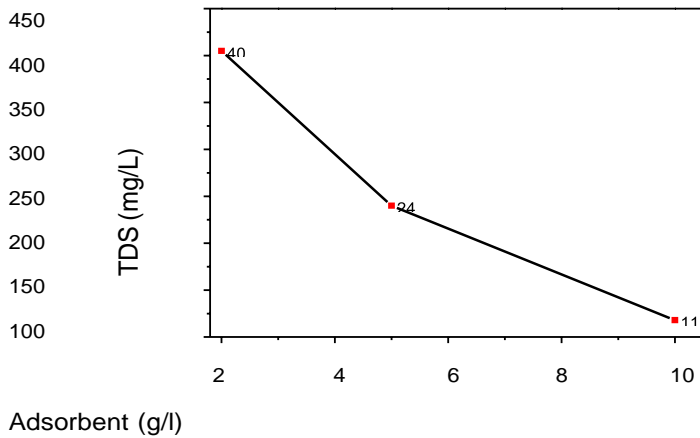


Fig: 4. TDS removal at different dosage of adsorbent media

Optimum Temperature and Adsorbent

After optimizing parameters (temperature and doses) at batch scale set-up, the pilot-scale experiments were performed by keeping the temperature 110 °C and adsorbent 10g/l constant. The boiler waste heat was utilized as an energy source to treat 10 liters of RO rejected water up to 5 cycles. The TDS removal was recorded at each cycle, as shown in table.2 :

Table: 2. Five experimental cycle setup at constant temperature and adsorbent

Cycle	Time (h)	Volume (L)	TDS (mg/l)
1	2.9	10	118
2	2.9	10	200
3	3.0	10	350
4	3.1	10	570
5	3.2	10	590

Conclusion

The present study validates the combined adsorption distillation (CAD) technique could be used as a promising treatment option by employing waste heat recovery from the boiler and utilizing it for treatment. In addition, By adopting the combined treatment option, adsorption and distillation enhance the TDS removal efficiency and provide a sustainable solution for handling the remaining salts after producing freshwater from rejected water. The parameters were optimized at lab scale set-up, and based on the conditions, the pilot-scale set-up of 10-liter capacity was designed and operated. The higher TDS removal (96%) was observed at temperature 110°C and adsorption dosage at 10g/l. Which showed that this adsorption distillation process could be used for RO rejected water and highlight the future research area for RO rejected water treatment.

Biochemical and Biochar Treatment of Saline Soil For Improving Nutrient-Water-Uptake

Samina Bhutto, Tanveer Ahmed Gadhi, Rasool Bux Mahar⁶⁶

Abstract

Soil Salinity is one of the major environmental issue Pakistan is facing in 21st Century, almost 6.8 million hectares of irrigated agricultural land in Pakistan is affected by it. This resulted in decreasing fertility and productivity of land and also impacting the yield of crops. The aim of this study was to determine the effects of various concentrations of salt on soil and mitigating these impacts using various treatments. Treatments with three different methods at different ratios was done i.e acid washing, microbial and banana waste biochar treatment. Meanwhile, the effect on the soil's physical and chemical properties, along with soil characteristics, plants' growth and the number of leaves, were monitored to determine the impact of these treatments on them. Results showed increased soil nutrient content with these treatments, while improving soil pH, electrical conductivity (EC), water holding capacity (WHC), and Cation Exchange Capacity (CEC). The physical properties of the saline soil were analyzed at the lab level, such as WHC, pH, EC, Nitrogen, Phosphorus and Potash (NPK). Treatment with combined biochar, strong acid (H₂SO₄), and microbes improve the soil's physio-chemical properties. Biochar and bio-chemical treatment were applied in 10 pots at rates of 10%, 20% and 30% of 90%, 80%, and 70% of the soil in pots. The effects on the soil's physical and chemical properties were improved. pH and EC were improved in Control pots pH and EC were 6.59 and 1303 mS/m.

Meanwhile, after treatment with 10% of Acid wash, 20% of microbes and 30% of biochar the pH of the soil was improved to 6.8 and EC to 70 mS/m. With the above-combined treatment, Potassium and nitrogen value were also improved (K in control 2.593 mg/Kg and improved 4.628 mg/Kg) and (N in control 4.714 mg/Kg and improved 29.02 mg/Kg). Water holding capacity of control pots were 64%, which after treatment increased to 98% and CEC) value was decreased to 3.4 meq/g. The best results were obtained at 10% of acid, 20% of microbes and 30% of biochar treatment.

Keywords: Soil Salinity, Banana Biochar, Bio-Chemical, Nutrient Water-Uptake, Water Holding Capacity.

Introduction

The beginning of 21st century is marked by global increased salinization of soil. Increasing human population and reduction in land available for cultivation is two. threats for agricultural sustainability. It has been estimated that worldwide 20% of total. cultivated and 33% of irrigated agricultural lands are afflicted by high salinity. Furthermore, the salinized areas are increasing at a rate of 10% annually for various reasons, including low precipitation, high surface evaporation, weathering of native rocks, irrigation with saline water, and poor cultural practices. It has been estimated that more than 50% of the arable land would be salinized by the year 2050. The problem of soil salinization is a scourge for agricultural productivity worldwide.

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Crops grown on saline soils suffer on an account of high osmotic stress, nutritional disorders and toxicities, poor soil physical conditions and reduced crop productivity. (Padam et al., 2014). Soil infertility implies lack of the qualities which enable it to provide nutrient elements and compounds in adequate amounts and in proper balance for the growth of specified plants. Nutrient-weak soil may be aggravated by poor soil mechanics, particularly poor binding properties which do not hold soil particles together in a porous, water-stable structure. Soil binding is the result of microorganisms exuding gummy substances during organic decomposition. Infertile soils lacking in decomposing organic matter such as manure, will lack nutrients and binding qualities as well.

For healthy growth, all plants require certain nutrients from the soil. There are 16 elements (carbon, hydrogen, oxygen, nitrogen, potassium, phosphorus, Sulphur, calcium, iron, magnesium, boron, manganese, zinc, copper, chlorine, and molybdenum) which, in varying quantities, are essential to plant growth. If any of these is absent from the soil or present in insufficient quantities, then the soil is said to be deficient. Bananas are one of the world's most important fruit crops and are widely grown in, tropical countries due to their valuable uses in the food industry. Its massive by-product is an excellent source of valuable raw materials for other industries through the disposal of agricultural waste. This avoids huge losses of unused biomass and environmental problems. Banana by-products such as peels, leaves are alternative sources of macronutrients and micronutrients.

Some places where "open fire burning" is still practiced, the burning of banana wastes may contribute to serious environmental issues. (Shrivastava & Kumar, 2015) Uganda, sometimes referred to as "Banana Republic", is among the World's 20 leading producers of banana with an annual production of 615,000 metric tons. Ninety percent of what is produced is consumed locally, generating large volumes of wastes that result from harvesting and processing such as: market-rejected bananas, banana peels, stems, and leaves.) Estimated 390,550 metric tons of waste peelings to have they come from an annual banana production of 610,000 metric tons. The waste is currently dumped into landfills, rivers, lakes, and other uncontrolled landfills as they decompose, creating significant environmental hazards. Although landfills are the most common form of dumping, they appear to be unsustainable due to the lack of land and the risk of pollution, especially in urban and peri-urban areas. Attempts to use these resources as fodder for cattle near the city are not enough to deal with the grief created. Therefore, there is a need. to develop appropriate waste disposal methods to reduce the negative impact on the environment. Biochar is one of the most profitable waste management techniques as an effective way to dispose of organic waste for economic and environmental benefits, as this process leads to a sustainable product, which can be used to improve and maintain soil quality and fertility. Application of crop residue compost to soil is considered as a good management practice because it stimulates soil microbial growth and activity with the subsequent mineralization of plant nutrients (Kalemelawa et al., 2012).

Large quantities of bananas sorted by waste from the juice industry and fruit markets daily indicate a potential natural resource which is a major environmental protection activity. We compared the effect of banana leaf waste and its biochar on the activities of the greenhouse gas emissions soil enzyme activities and chemical properties of soil. Globally, on average 30- 40% of total food was wasted in terms of production, transportation, and consumption. There were about 3.5 million tons of banana leaf waste produced annually by the world food industry. This peeled fruit is produced in high quantities every year which represents biomass that can be converted to biochar as a carbon source through thermal pyrolysis technology and control the environmental problem. (Sial et al., 2019). It has a very positive impact on agriculture and the ability to rehabilitate polluted soils by improving soil physiochemical properties to reduce nutrient depletion and improve nutrient availability).

Biochar can also be used to increase water storage capacity), improve the microbial activity of the soil and protect the soil from indigenous pathogens, improve soil quality. (Islam et al., 2019).

Materials and Methods:

The experiment is a pilot scale should conduct at the USPCAS-W center of Mehran University of Engineering and Technology Jamshoro, Sindh, Pakistan during the year of 2022. For the improvement of saline soil using banana waste biochar and the biochemical treatment and assess the soil nutrient water uptake, physio-chemical properties, and plant growth.



Fig:01 site area image from google earth

Methodology flowchart

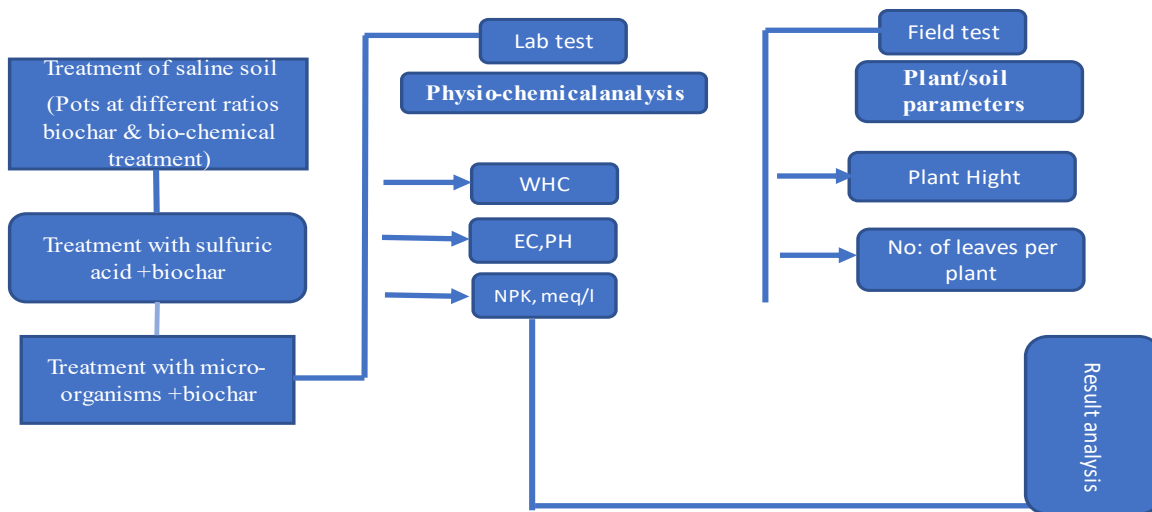
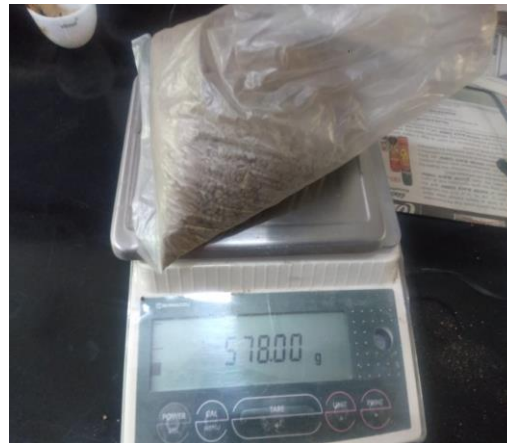


Fig:02 methodology flow chart

Preparation of soil treatment:

The soil treatment with by adding the biochar with bio-chemical at different ratios three different

ratios are selected, for better soil treatment A1, A2, and A3. A1 is the mixture of 10% of sulfuric acid + biochar. A2 is a mixture of 20% of Sulfuric acid + biochar, and A3 is the mixture of 30% of sulfuric acid + biochar. While the same process is applied to micro-organisms



Description of treatments

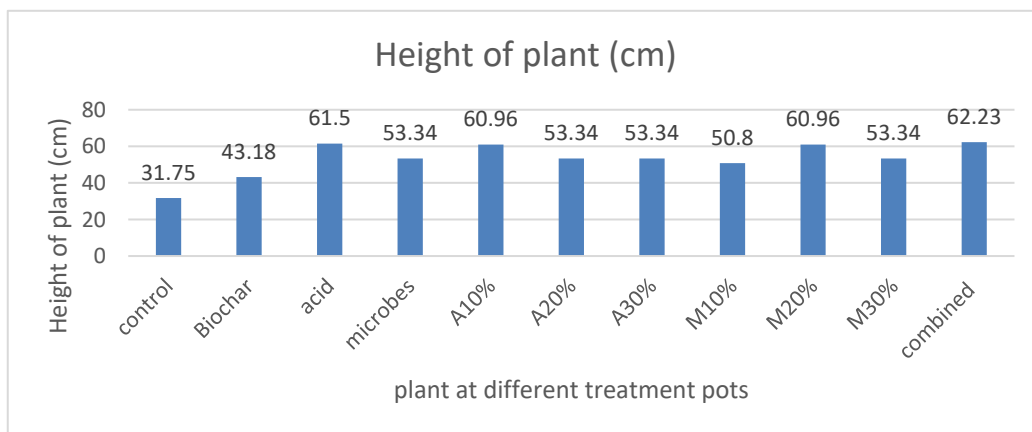
To find out the best ratio of soil treatment with biochar and bio-chemical which were applicable for fields. Eleven pots were prepared in which different ratios were used to get the optimize proportion of treatment the ratios are 10%+90%, 20%+80% & 30%+70% of biochar and bio-chemical and compared their results with a control (only soil) and chemical fertilizer pots.

Results and Discussion:

Effect on saline soil after treatment soil on plant growth

The Height of corn crop is represented in fig.5 respectively the result shows that the largest height of corn plant found at combined treatment (biochar+bio-chemical). At control it recorded the lowest 31.75cm and highest at combined treatment 62.23cm respectively compares to all other ratios.

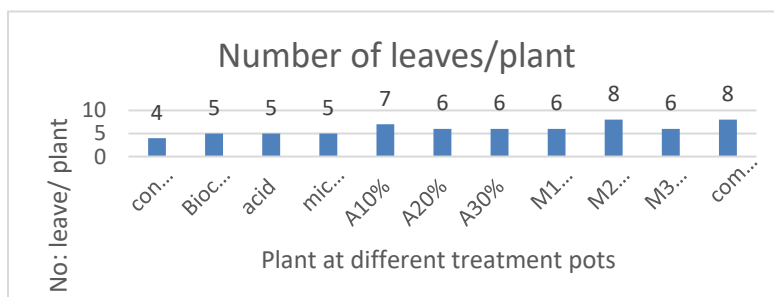
Fig:05 shows the height of the corn crop (cm)



Effect on saline soil after treatment soil on number of leaves

The number of leaves of corn crop I represented in fig.6 respectively the result shows that the greater number of leaves of corn plant at combined treatment and M20%. At control it recorded the lowest number of leaves 3 and higher is 8 respectively compares to all other ratios.

Fig:7 shows the number of leaves of the corn crop /plan

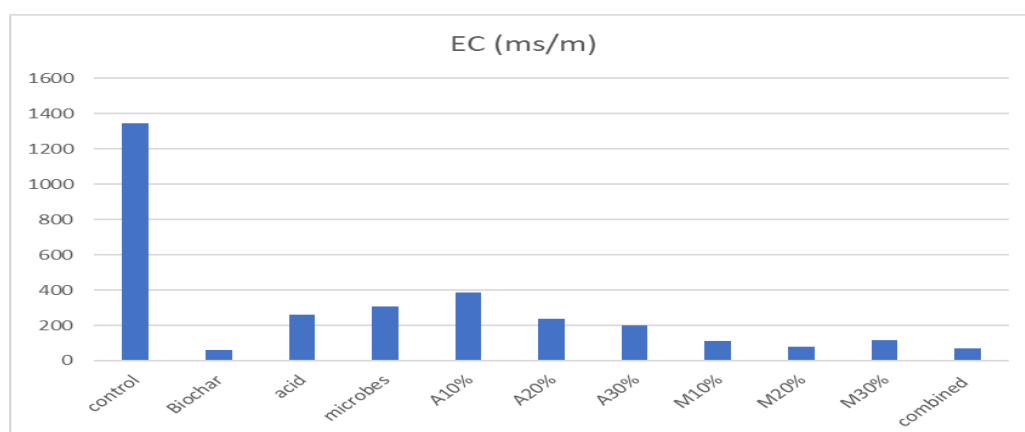


Effect on physio-chemical properties of saline soil

Effect of soil treatment on soil EC

It shows that by addition of biochar and bio-chemical in soil at different ratios also maintain PH and the electric conductivity of soil. Fig.8 shows that variation of soil pH and soil Ec values at different treatment pots. The recorded PH and EC values at control pots are 6.4 and 6.9 and EC from 1303 to 70 mS/m respectively.

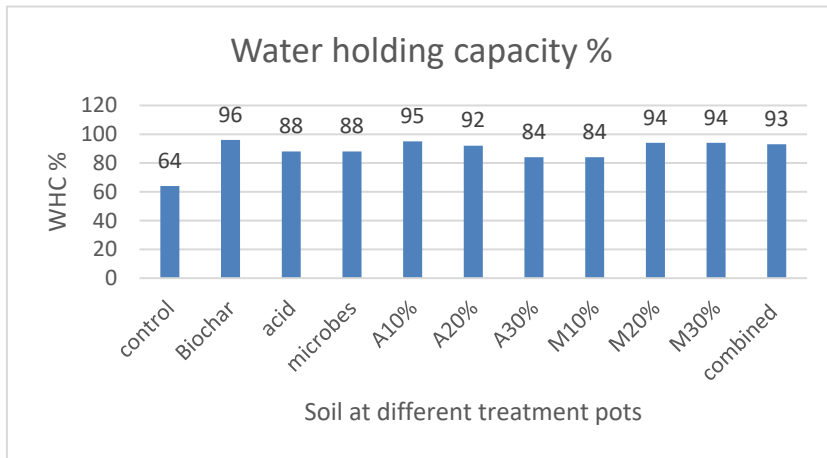
Fig:08 shows the variation in EC at different treatment pot



Effect of treatment on saline soil on soil hydro- properties WHC%

In this research silty clay soil with poor water holding capacity was used and treated with different ratios of treatment to increase the water holding capacity as soils with water holding capacity are always the ideal soil for agricultural. The result shows that the poorest water holding capacity were recorded at control pot with 64% and the highest water holding capacity were recorded at treatment pot A10%, M20% and combined treatment.

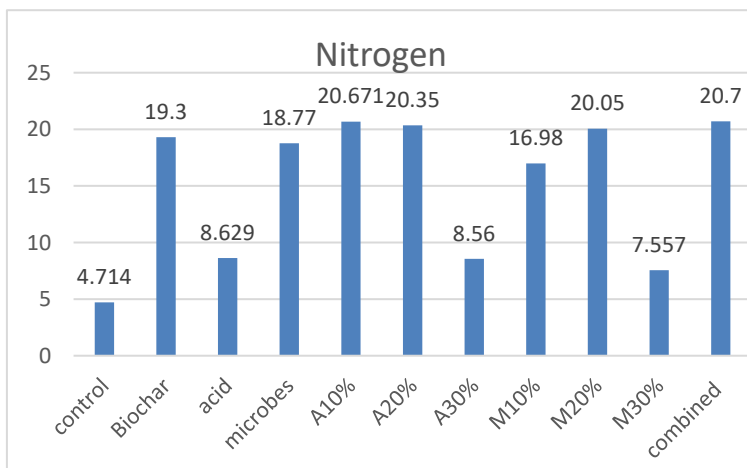
Fig:9 shows the water holding capacity (WHC) % of different treatment pots



Effect of treatment on saline soil on soil nitrogen N

The biochar which is derived from organic waste was rich in nitrogen. The nitrogen is basic nutrient for the growth of every crop. The result shows that soil at different treatment pots has different concentration of nitrogen. The lowest concentration of nitrogen were recorded at control which is 4.714 and highest value were recorded at the combined treatment.

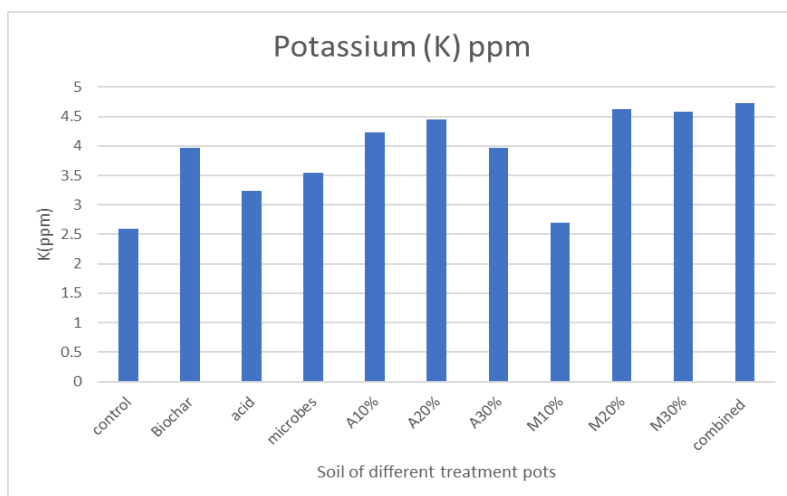
Fig:11 shows the concentration of nitrogen (N) mg/kg in different treatment pot



Effect on saline soil after treatment soil on soil Potassium (K) ppm

The biochar which is derived from the organic waste was is rich in potassium. The potassium is the basic nutrient for growth of every type of plant. The result shows that soil at different treatments pots has different concentration of potassium. The lowest concentration of potassium was recorded at control which is 2.593 ppm and highest potassium value wererecorded at combined treatment 4.725 respectively.

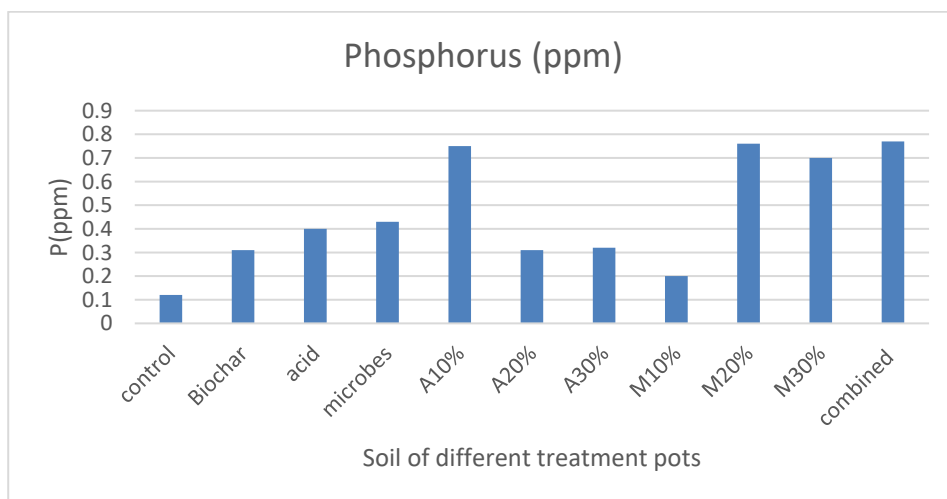
fig:12 shows the concentration of potassium (K) mg/kg at different treatment pots



Effect on saline soil after treatment soil on soil Phosphorus (ppm)

The biochar which is derived from the organic waste was rich in phosphorus. The phosphorus is the basic nutrient for growth of every type of plant. The result shows that soil at different treatments pots has different concentration of phosphorus. The lowest concentration of phosphorus was recorded at control which is 1.2 ppm and highest phosphorus value were recorded at combined treatment 1.77 ppm respectively.

Fig:12 shows the concentration of phosphorus (P) mg/kg at different treatment pots



Conclusions

The best result came by adding 10% of acid 20% of microbes and 30% of biochar) 70% of soil compares to other control soil and single treatment of soil. It increases the WHC of soil from 64% to 93%, potassium from 2.593 to 4.728 ppm, and nitrogen from 4.716 to 20.05 ppm, phosphorus from 0.12 to 0.76 ppm and good plant growth at this ratio. The addition of resulting that treatment could be beneficial to improve agricultural productivity and soil health, and the study was sustainable way for water consumption

Biochar and bio-chemical treatment produce a crop productive condition for saline soil, by adding biochar and biochemical into saline soil to improve nutrient water uptake of soil at different ratios and to investigate the feasible proportion of these, for agricultural productivity. Through this study water conservation can be done by increasing water uptake in the soil, to improve physio-chemical characteristics of the soil, decreased erosion potential, increased biological activity, and increase the soil fertility.

Carbonization and Activation of Banana Leaves for Removal of Ni, Pb, Cr and mixed solution of heavy metals from wastewater

Safia, Tayyab Ahmed Qureshi, Tanveer Ahmed Gadhi*, RasoolBux Mahar⁶⁷

Abstract

Heavy metals contained in industrial effluent and wastewater are significant environmental contamination hazards. Examples of heavy metals are considered: copper, silver, zinc, cadmium, gold, mercury, lead, chromium, iron, nickel, tin, selenium, molybdenum, cobalt, manganese, and aluminum. These metals have a major potential to enter the human body and cause cancer, bone and brain damage, and damage to the nervous system. Moreover, abundant banana waste production and open burning is an environmental issue. This study offers a distinctive, affordable, widely available, and insoluble solution in most solvents' adsorbents. Dried and ground banana leaves (BL) are used as adsorbents and precursors to produce activated carbon in a carbonization reactor. A comparison study was investigated between non-activated and chemically activated carbon (CAC) thermally activated carbon (TAC) adsorbents for Lead(Pb), Nickel (Ni), Chromium (Cr), and mixed solution removal from wastewater. Characterizations using a scanning electron microscope and Fourier-transform infrared spectroscopy showed that the synthesized Banana leaves had a rough surface, porous structure, Aromatic ring, Nitro compounds and other functional groups. The effects of initial concentration and time were investigated. The results of the adsorption study showed significant sensitivity toward the Pb, Ni, Cr, and mixed solution ions at optimum conditions. The ions uptake was increased with increasing contact time and agitation speed, and it achieved the best selectivity and removal efficiency of Pb (66%, 95% and 96%), for Ni (60%, 93% and 97%), and Cr(63%, 82% and 97%) in case of CAC and TAC, respectively, at the aqueous solution pH 4 and 5. The removal efficiency attained in the mixed solution was slightly lesser than individual ions. The kinetics studies show that the adsorption process follows the pseudo-first-order kinetic model, and the pseudo-second-order kinetic model fits well. The results of the experiments proved that the developed adsorbents were superior to those that were previously in use

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Improvement of Soil Fertility and Water Conservation using Co-Composted Soil Amendment

Shaista Mangi, Tayyab Ahmed Qureshi, Tanveer Ahmed Gadhi, RasoolBux Mahar⁶⁸

Abstract

Outdated water conservation and soil management methods in agriculture have decreased the productivity and fertility of lands in Pakistan. Using organic soil amendments for soil management and water conservation is one of the best practices adopted worldwide. Compost enhances soil porousness and forms aggregates and the soil structure. Biochar moderates soil thermal properties, buffers soil pH, enhances soil water holding capacity (WHC), and lessens soil bulk density. The present study involves the production of co-composted soil amendments consisting of biochar derived from plant biomass with a cation exchange capacity (CEC) value of 5.3 meq/g and compost formed from sewage and animal waste 3.2 meq/g CEC to enhance the nutrient water uptake capacity of the soil. This study aimed to prepare a co-composted soil amendment, optimize the ratios and mode of prepared amendments, and evaluate its properties. Co-composted soil amendments A₁, A₂, and A₃, were prepared with three different ranges, between 10-30% of biochar to compost. Two crops, rigid guard and corn, were grown in sandy, clayey loam with less WHC of 38%. Eleven different pots were prepared, and the amendment to soil ratio was between 10-30%, also compared their results with control, compost, and chemical fertilizer pots. Pre and post-analyses were performed in the lab and field. WHC, CEC, Electrical Conductivity (EC), pH, Total Nitrogen (TN), Phosphorus (P), Potassium (K), Total Carbon (TC), Organic Matter (OM), and Total Organic Carbon (TOC) were analyzed. Moreover, plant height, number of leaves/plants, and fruit length were also analyzed. The whole process took 3-4 months. The best results came by adding 30% of amendment A₃ (30% Biochar + 70% Compost) to 70% of the soil, increasing the WHC of soil from 38% to 79.2%, potassium from 2.257 mg/Kg to 3.299 mg/Kg, and Nitrogen from 0.2779 mg/Kg to 19.04 mg/Kg and good plant growth at this ratio. The addition of resulting co-compost could be beneficial to improve agriculture-water productivity and soil health.

Keywords: Co-composted soil amendment, water conservation, soil fertility

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Drinking water Storage management and Hygiene practices in Karimabad Hunza (Gilgit-Baltistan).

Asiya Aman and Naveed Ahmed Qambrani⁶⁹

Abstract

Karimabad is a valley situated in the heart of Hunza district of Gilgit-Baltistan Pakistan. The region is blessed with a variety of natural resources, which includes mountains, pastures, fruit orchards but glaciers and springs provide the most prominent source of fresh water. The community is depending on spring water as a drinking water source in all seasons however due to limited availability of spring water the residents employ a variety of methods for water storage for later consumption. According to the questionnaire survey conducted in Karimabad, people were either using overhead water tank or Drums and bottles to store drinking water. Almost very few were washing the water storing container on regular basis among which storing in bottles were common. While households using overhead tanks never washes their water storing container. Besides having knowledge of water boiling practices people do not boil water before consumption. Moreover 26% respondents were not using proper lid or cover to protect water storing container while 74% were using lid to cover the water container. Water quality assessment and questionnaire survey showed that due to improper and inefficient water storing techniques the water contamination occur. A proper awareness session should be given to the community on regular basis regarding effective ways of water storing techniques at household levels.

Keywords: Assessment, Household, water storage, Contamination, spring water

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Eco-innovation for sustainable growth in Pakistan: Marble Sector

Zubair Ahmed⁷⁰

Abstract

Marble Sector is considered one of the important sectors in Pakistan. There are more than 1400 marble stone mines and more than 2700 marble stone cutting and polishing units. This sector is estimated to produce about 3.82 million tons of finished marble annually. Besides, this sector also contributes to environment. WATER tal pollution and the exploitation of natural resources. Eco-innovation is a complex process involving the production and exploitation of products, processes, services, or business methods that are novel to the organization (developing or adopting it) and results in reducing environmental risks and improving environmental sustainability. This study was carried out to investigate and introduce eco-innovation options in the marble sector to promote sustainable production and consumption in the marble sector. For this study, secondary data were collected from literature and published reports. The questionnaire survey and focused group meetings (FGMs) with marble stakeholders were also conducted at the Manghopir marble industries area, Karachi, to map the current status of marble industries. The marble sector also faces problems such as high electricity and water consumption, associated costs, and disposal of marble powder (slurry). Surveys and interviews revealed that, on average marble cutting industry in the Manghopir area has a monthly production of 1307 tons, while the polishing industry produces 220 tons of finished marble products. It is estimated that the average electricity consumption of the marble cutting industry is about 19500 units/month, and the marble polishing industry is about 2000 units/month, while each marble cutting industry generates 4000 – 5000 gallons/month of marble slurry. Marble Industries are paying higher costs for the disposal of marble powder (slurry) and machine maintenance. This study explored various alternative solutions to mitigate the environmental issues of the marble sector, including water and energy conservation, alternate energy use, and utilization of marble powder (slurry) as raw material for other products. In a focused group meeting with stakeholders, it is revealed that marble industries have three major barriers: technological, financial, and capacity.

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Wastewater Management to Cope with Water Pollution and Water Scarcity

Author: Musawar Hussain

Abstract

Water is one of the potent natural resource and base of life on earth. 71% of earth surface is covered with water but still water scarcity is an emerging issue. 71% is not freshwater that is not drinkable water for human beings. Only 3% (2% cryosphere, & 1% rivers, lakes, aquifers) is freshwater, and remaining 97% is in oceans that is highly saline. Introduction of undesired particles in water more than contamination limits cause water pollution which accelerate the water scarcity. There are 2 sources of pollution, natural or anthropogenic. Anthropogenic include industrialization, urbanization, population growth, agriculture, car wash stations and sewerage waste etc. Natural resources include dust storms, precipitations, leaching processes, and coastal intrusions. Water pollution change the physical, chemical and biological attributes of water which cause harmful impacts such as, environmental hazards, biodiversity loss, particularly public health and safety issues. Water scarcity and water pollution can be managed through different means additionally, type of sewage treatment depends upon the type of sewage, either it is industrial, domestic, or any other. One of the most common things is the sewage treatment plants which treat the water and other techniques involve the construction of wetlands, infrastructure development, gravity mechanisms, chlorination, aeration techniques, and radiation exposure etc. Change in human behavior is an awesome thing to manage the water resources, less use of water more conservation will happen. Treated water known as gray water and can be used in various processes, even some treatment make water as good as drinkable. We can use gray water in washing, bleaching, irrigation, sanitation and others, depending upon type of treatment. These altogether help us to cope the water scarcity and wastewater management.

Keyword: Water as essential resource, Water scarcity, Water pollution, Sewage treatment and management.

Tannery wastewater: A review of its impacts and mitigation measures in Pakistan

Ali Abbas⁷¹, Shahbaz Nasir Khan⁷², M. Farooq Anwar⁵⁰, Ali Bin Khalid⁴⁹, Asma Batool⁴⁹, Musawar Hussain⁴⁹, Asad Abbas⁴⁹ and Ali Danial⁴⁹

Abstract

This planet is constantly threatened by environmental pollution. The tannery industry has become one of the major causes of air, water, and soil deterioration. The raw material used for the tanning process is the hides and skins of various animals. These are converted into finished leather products like shoes, jackets, bags, and sports goods after the tanning process. The color of wastewater from the tannery industry is blackish which contains solid waste, organic matter, and chromium. According to recent studies, this wastewater has EC, TDS, pH, BOD, and COD up to 23.08 $\mu\text{s}/\text{cm}$, 11.54 mg/L, pH 8.21, 420 mg/L, and 1123 mg/L respectively. While the NEQS for these parameters i.e. EC, TDS, pH, BOD, and COD are 7 $\mu\text{s}/\text{cm}$, 3500ppm, 6-9, 250 mg/L, and 400 mg/L respectively. Although the tannery industry significantly contributes to the economy of Pakistan. This industry is the most important sector for export earnings due to which it ranked 2nd number in the economic status of Pakistan. It employs more than 5 million people and contributes 5% of the GDP of Pakistan. There are approximately 600 tanneries present in three cities of Pakistan Sialkot, Kasur, and Karachi. Tannery waste pollutes the whole natural environment with trace metals and causes health problems like dermatitis, asthma, various neurological disorders, and hepatitis. This deterioration in water quality also severely impacts the biodiversity of the river. This type of wastewater can be treated biologically like the process of floating treatment wetland methods. In this method, some specific species of plants are used to treat effluent through phytoremediation. Synthesis of eco-friendly green ZnO Nano-particles from algal sources can also help in decreasing the impacts of hazardous material released through the tanning process. The sludge process is also used for the treatment of tannery wastewater based on the aeration of this water by flocculation growth of biological parameters. In the end, it is concluded that the tannery industry is continuously deteriorating the quality of freshwater which disturbs the soil, air, biodiversity, ecosystem, and human health which can be minimized by employing the above-mentioned methods to save the environment.

Keywords: Tannery wastewater, water pollution, NEQS, biological treatment.

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Biofouling Organisms in the Coastal Waters of Karachi with Special Reference to Karachi Harbour

Sumaira Khatoon, Javed Mustaqim and Ghazala Siddiqui⁷³

Abstract

Marine biofouling is an ever-increasing problem faced by maritime countries from both environmental and economical points of view. Accumulation of fouling organisms such as barnacles, sponges, mussels, seaweeds etc. on ship's hull increases fuel consumption, emission of Green House Gases (GHG), and transportation of harmful alien or non-indigenous species. The consequences of biofouling are not restricted to shipping industry alone. It poses an extensive challenge to other industries in developing technologies, especially in marine renewable energy sector and also in marine aquaculture sector. These industries rely on submerged equipments and structures to capture energy from offshore wave, wind and tide and to culture marine fishes. However, biofouling makes it difficult to keep the equipments and structures operational as biofouling requires regular maintenance and constant cleaning. The fouling organisms occurring in the coastal waters of Pakistan have received little attention and practically nothing is known about non-indigenous species that have been introduced in our coastal waters. A baseline study is therefore required for the better management and monitoring of the biofouling related problems. This being the case, the present study was initiated. Samples of Macrofouling organisms were collected from navigational buoys, boat's hull and jetty pillars located in the Manora Channel of Karachi Harbour, in October 2017 and May 2018. Five navigational buoys, one fiberglass boat and three concrete pillars were sampled. Seawater surface temperature, salinity, pH, and dissolved oxygen were recorded on both occasions. In laboratory, Macrofouling organisms were identified to the lowest taxonomic level possible. A total of 47 species in 8 phyla were recorded. The most abundant group of Macrofouling organisms was barnacles (51.1%), followed by segmented worms (19.7%), pelecypods (11.8%), and amphipods (9.9%). Crabs, gastropods, sea-anemones, isopods, sea-spiders, peanut worms, and insect larvae were also present in the samples, though in relatively small numbers. Species richness, diversity, evenness, and similarity indices were also computed using Microsoft Excel spreadsheet.

Key Words:Biofouling, Manora Channel, Karachi Harbour, Pakistan

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Bio-sensing platform based on green synthesized iron oxide nanoparticles for the detection of waterborne bacterial pathogens

Syeda Sara Hassan, Ramsha Aijaz⁷⁴

Abstract

Affordable testing of water is an urgent need in poor countries like Pakistan, where my research interests focus on improving the quality of life for poor communities. Pakistan faces intense health problems due to water pollution and this problem is intensifying day by day. The work of this research is very advanced for microbial pollutant detection using electrochemical biosensor. Proper diagnostics and treatment is luxury that few can afford in Pakistan. In this present study, we reported the successful use of *Azadirachta indica* (neem leaves extract) by bottom-up method for the green synthesis of smallest stabilized economical iron oxide nanoparticles. Overall, the proposed green synthetic one pot method was simple and eco-friendly, and alternative to the conventional toxic reducing agents use before. After synthesized the nanoparticles size, shape, charge and functionality is confirmed by different analytical characterization techniques such as UV-Visible spectroscopy is the first initial characterization technique to confirmed the formation of nanoparticles and give the wavelength at 260 nm, The spherical size morphology of the iron oxide nanoparticles appeared in between the range of 20-40 nm proved as an good catalytic property for developing a biosensor, FTIR proved the strong functional group interaction of iron salts with reducing agent. Zeta potential analyzer proved that particles are highly stable and contain a negative surface charge with a zeta potential value is -9.11 mV, The XRD pattern of Fe_3O_4 showed that six characteristic diffraction peaks of Fe_3O_4 were observed at planes $38^\circ = (48)$ at $44.63^\circ (165)$ at $48.95^\circ, (25)$ at $64.77^\circ, (28)$ at $72.69^\circ, (180)$ proved that particles are spherical and crystalline in nature. Then to check the catalytic performance of nanoparticles with the help of bipotentiostat electrochemical workstation (three electrode system) by developed a modified magnetic iron oxide nanoparticles biosensor by drop cast method using screen printed zensor (biosensor) as an working electrode to detect the specific *E. Coli* from synthetic water samples and then in real water samples of MUET water treatment plant having LOD of 0.425 CFU/mL with linear correlation value of $R^2 = 0.934$ in the range of 10^1 to 10^7 CFUs/ml. The outcomes of this biosensor is to improve the drinking water quality of multiple systems of Mehran water treatment plant Jamshoro, Sindh. The novel alternative method for the monitoring of drinking water for pathogenic bacteria is specific, reliable, economical, fast, simple, less time consuming and less amount of chemicals, cost effective and highly stable compared with conventional methods.

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Geophysical investigations and physio-chemical analysis to delineate the groundwater quality in the Central Part of Bari Doab, Punjab, Pakistan

Pervez Khalid, Shahbaz Muhammad, Muhammad Irfan Ehsan⁷⁵

Abstract

The land of Punjab is the part of interfluvial system of Doabs. The study area is the western part of district Okara lies in the central part of Bari Doab. The investigations of groundwater condition were carried out integrally by using hydrogeophysical technique and physio-chemical analysis of groundwater samples. The Schlumberger electrodes array for electrical resistivity survey (ERS) was utilized as geophysical technique allied with lithological drill-logs and physio-chemical analysis of groundwater samples to obtain a comprehensive depiction of present subsurface groundwater condition of the study area. To investigate the subsurface hydrogeological conditions, thirty (30) vertical electrical soundings (VES) with Schlumberger electrodes arrangement at sparsely distributed locations were executed in study area. Three to six subsurface geo-electric layers are interpreted through electrical resistivity data modeling for different VES locations. The calibration is also carried out between lithological drill-logs and software-aided processed resistivity models of the study area. On the basis of geological settings and processed resistivity models, the interpreted resistivities are classified as very high, high, medium, low and very low. The interpreted results demarcate the spatial distribution of fresh, marginally fit and saline / brackish groundwater zones. The interpreted 2D and 3D models of the study area decipher that the salinity of groundwater starts just below the water table at northern part of the study area. The salinity increases with depth and covers almost 50% of the study area at depth of 300 m. Up to this depth, rest of the study area is interpreted to be saturated with fresh and marginally fit groundwater zones. Below the water table, low to very low resistivity layers are interpreted as saturated with marginally fit and saline / brackish groundwater respectively. The subsurface layers dominant with sand-gravel having medium to very high resistivities are considered as the most promising zones of good/fresh quality groundwater. However, yield of water in very high resistivity zones may be compromised to some extent at different subsurface levels due to the stiff kankar inclusions. To evaluate shallow groundwater conditions (up to 75 m) in details, a total of 40 well distributed shallow groundwater samples were taken from the study area for physio-chemical analysis. 2D and 3D models of total dissolved solid (TDS), electrical conductivity (EC) and pH were developed to observe the distribution of these parameters in the study area. Moreover, five sparsely distributed samples targeting the populated areas were selected for detailed physio-chemical analysis in laboratory to determine cations, anions and arsenic content. The results of the detailed analyses are categorized according to the guidelines of world health organization (WHO).

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Effects of Industrial Effluents on Physico-Chemical and Nutritional Parameters of Maize

Basmina, Gulfan Ullah, Amana Khatoon, Ghazala Nawaz⁷⁶.

Abstract

Sugar industry is a very important agro-based industry and it discharges large amount of effluents into water bodies to create high pollution in water bodies which affects the plants and other living organisms. In the present research study, numbers of roots were calculated. The results indicated that the increase in sugar mill effluents concentration caused a marked increase in hydrogen peroxide (H₂O₂) contents, activities of antioxidant enzymes such as superoxide dismutase (SOD), catalase (CAT), peroxidase (POD) and ascorbate peroxidase (APX) in maize. The impact of different concentrations (control, 5, 10, 25, 50, and 100%) of Chashma sugar mill effluent on seed germination, physico-chemical and nutritional parameters of maize was studied. The morphological parameters such as germination percentage, shoot length, root length, fresh weight and dry weight of seedlings, number of leaves and number of roots in maize. The increase in anti-oxidative potential enabled maize plants to withstand sugar mill effluents induced oxidative stress in maize. Results also showed that the morphological, physiological, physico-chemical and nutritional parameters gradually decreased with increasing concentration of sugar mill effluents.

Key words: Effluents, oxidative stress, Chashma sugar mill, Catalase, Water bodies.

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THEME 4

ISLAMIC PERSPECTIVE ON CLIMATE CHANGE, WATER POLLUTION & WATER MANAGEMENT

آبی آلودگی اور عصر حاضر کے تقاضے (شریعت اسلامیہ کے تناظر میں)

A study of water pollution and contemporary Requirements (in the context of Islamic Shariah)

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Abstract

The Water symbolizes life on the earth. All kinds of existence depend on water. Allah has created great reservoirs of water on this earth which cater to the needs of all living beings, but human negligence is making these resources polluted. Pollution not only poses threats to human life, it also endangers marine life and resources. These threats have been increased manifold by industrial revolution and increasing human population. The same factors are also responsible for the increased use of water. Many countries have employed distillation processes to provide clean water for the increasing demands of population, agriculture and industries. Islamic jurisprudence also takes into account different types of water, some of which can be used in cleansing rituals for worship, while Islamic Jurist accept it as "Istihalah"? The following study will outline the details of distilled water to see whether it can be used for daily chores and ablution rituals or not.

Keywords: Qur'an, Water, Living hood, Islamic Prospective

اللہ تعالیٰ نے انسان اور تمام مخلوقات کو پیدا کیا اور ان کی تمام ضروریات کے لئے تمام اقدامات فرمائے۔ ان ضروریات میں سے انسان کی زندگی میں پانی کی بہت زیادہ اہمیت ہے، پانی سے انسان کی تخلیق بھی ہوئی ہے اور اس کے زندہ رہنے کے لئے پانی کی قدم قدم پر ضرورت پڑتی ہے، پیاس بجھانے کے لیے، کھانا بنانے کے لیے، برتن اور کپڑے دھونے کے لیے، پاکی حاصل کرنے کے لیے کھیتوں کی سیرابی، درخت و پودوں کی ہریالی برقرار رکھنے کے لئے پانی نہایت ہی ضروری ہے۔ اللہ تبارک و تعالیٰ نے قرآن کریم میں جگہ جگہ پر پانی کی اہمیت کو بیان کیا ہے، اس کو اپنی قدرت، اور انسانوں کے لیے عظیم نعمت قرار دیا ہے۔

پانی کی اہمیت کے پیش نظر ٹھہرے ہوئے پانی میں پیشاب کرنے سے منع کیا گیا ہے۔ حضرت جابر رضی اللہ عنہ سے روایت ہے کہ رسول اللہ ﷺ نے ٹھہرے ہوئے پانی میں پیشاب کرنے سے منع کیا ہے۔ پانی میں پیشاب کرنے سے منع کرنے کی یہ وجہ بھی ہے کہ اس سے پانی گندہ اور ناپاک ہو جائے گا اور تعفن پھیلے گا، جس کا اثر ہماری صحت پر پڑے گا، دوسری طرف ایسے پانی سے استفادہ بھی ناممکن ہو جائے گا اور ہم اس پانی سے دیگر گندگیوں کو پاک

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وصاف نہیں کرسکیں گے۔ اس کا اثر براہ راست ہم پر اور ہمارے ماحول پر پڑے گا جس سے طرح طرح کی بیماریاں پیداہوں گی، پیٹ، گڈنی، پیشاب، خون کی زیادہ تر بیماریاں آلودہ پانی کے استعمال کرنے کی وجہ سے ہوتی ہے، آلودہ پانی کے ذرات کی وجہ سے خاص طور پر بچوں میں دماغی بیماریاں ہوتی ہیں۔ ایک رپورٹ کے مطابق برصغیر میں ۲۰۱۳ء میں دس ملین سے زائد لوگ پانی سے پیداہونے والی بیماریوں سے مر چکے ہیں، اور مرنے والوں میں اکثر بچے ہیں۔ اس لیے پانی کی حفاظت کرنا اور اس کو آلودہ ہونے سے بچانا ضروری ہے۔

اس وقت پوری دنیا کے لئے ماحولیاتی آلودگی کا مسئلہ سنگین نوعیت اختیار کر گیا ہے اور اس کی وجہ ظاہر ہے کہ انسان نے زندگی کے مختلف شعبوں میں سائنس اور ٹکنالوجی کی بدولت ترقی کی دوڑ میں ماحولیات کو نظر انداز کر دیا ہے اور تعیش پسندی میں انہماک، مال اور منافع کو کسی بھی طریقے سے کمانے اور پیداوار کو غیر فطری طور پر تیز رفتاری سے بڑھانے کی آرزو اور ذاتی خواہشات کو معاشرہ کے مفاد پر اور جلدی حاصل ہونے والے فوائد کو دیر پا فوائد پر ترجیح دینا، اس کا شیوہ بن گیا ہے۔ جس کی بنا پر ہوا، پانی اور زمین کی طبعی، کیمیائی اور حیاتیاتی خصوصیات میں ناپسندیدہ اور نامناسب تبدیلیاں پیدا ہو گئی ہیں اور زمین کے درجہ حرارت میں نقصان دہ حد تک اضافہ ہو گیا ہے، جس کی بنا پر عالمی حدت (Global warming) کا مسئلہ پیدا ہو گیا ہے۔

چنانچہ ان تبدیلیوں سے انسان اور دیگر جانداروں کی زندگیوں کو خطرہ لاحق ہو گیا ہے اور اس بات کا خدشہ پیدا ہو گیا ہے کہ مکمل طور پر ان کی زندگی ہی ختم ہو جائے۔ جب کہ ماحولیات (Environment) وہ سب کچھ ہے جس میں انسان یا دیگر جاندار رہتے ہیں۔ چنانچہ زمین، جنگل، پہاڑ، دریا، صحرا، مختلف النوع جاندار جیسے انسان، پرندے، حشرات الارض اور بڑے بڑے جانور اور چھوٹے جاندار یہ سب ماحولیات کے لازمی اجزا ہیں اور یہ سب اپنی فطری زندگی میں ایک دوسرے کے لئے ضروری ہیں، لیکن اب انسان نے فطرت (Nature) میں مداخلت (Interference) کو درہم برہم کر دیا ہے، جس کی وجہ سے وہ فضائی (Air Pollution)، آبی (Water Pollution)، زمینی (land Pollution)، صوتی (Sound Pollution)، سمندری (Sea Pollution) اور شعاعی آلودگی (Radial Pollution) سے دوچار ہے، چنانچہ فضا میں انسان اور ماحول (Environment) کے لئے مضر مادوں کی بھاری تعداد موجود ہے، جس کی وجہ سے ہوا کے قدرتی اجزائے ترکیبی بگاڑ کا شکار ہو کر رہ گئے ہیں اور پانی میں بھی ناپسندیدہ اشیاء کی بڑی مقدار جیسے ٹھوس کے ذرات، حل شدہ نمکیات، صنعتی ناکارہ اشیاء، گرد و غبار اور حیاتیاتی اشیاء

موجود ہیں، جن سے پانی آلودہ ہو کر متعدد بیماریوں کے پھیلنے کا ذریعہ بن گیا ہے۔ اور زمین بھی اپنی طبعی، حیاتیاتی اور کیمیائی (Chemical) ترکیب میں تبدیلی سے دوچار ہے، نیز بے ہنگم اور غیر ضروری آواز کی وجہ سے صوتی آلودگی (Sound Pollution) پیدا ہو گئی ہے، جس سے انسانی صحت پر مضر اثرات مرتب ہو رہے ہیں۔

اسلام جو کہ دین فطرت اور اعتدال ہے، اس نے ماحولیات اور قدرتی وسائل (Natural sources) جیسے جنگلاتی وسائل (Forest Sources)، آبی وسائل (Alimental Sources) اور زمینی وسائل (Land Sources) کی بقا اور تحفظ کے لئے مختلف اقدامات کیے ہیں اور ہر ضرورت کو پیش نظر رکھتے ہوئے مکمل رہنمائی بھی فرمائی ہے۔

آلودگی کی تعریف:

کسی ایسی چیز کا اضافہ (مائع، گیس، ٹھوس) یا توانائی کی کوئی بھی شکل (جیسے حرارت، آواز، تابکاری) اس شرح سے زیادہ تیزی سے ماحول میں شامل ہوتی ہو جس شرح پر وہ گلتی، حل یا منتشر ہوتی ہو تو آلودگی کہلاتی ہے۔ آلودگی کی خاص قسمیں فضا کی آلودگی، پانی کی آلودگی، شور کی آلودگی، پلاسٹک کی آلودگی وغیرہ شامل ہیں۔

آلودہ پانی کی تعریف:

قدرتی یا انسانی سرگرمیوں کے نتیجے میں پانی کی ماہیت یا اجزاء ترکیبی میں ہونے والی تبدیلی جو پانی کو پینے، گھریلو استعمال، صنعتی، تفریحی، جنگلی حیات، اور دوسری ضروریات کے لئے غیر موافق بناتی ہے۔ ایسے پانی کو آلودہ پانی کہا جاتا ہے۔ پانی میں ایسی غیر ضروری اشیاء کا اضافہ جو کہ انسان حیوان اور آبی زندگی کے لئے خطرناک ہو یا پانی کے اندر یا اس کے گرد پیش معمولات زندگی کو متاثر کرے۔

آلودہ پانی کے ذرائع:

پانی کو آلودہ کرنے کے مختلف ذرائع ہیں بعض ان میں معلوم ذرائع ہوتے ہیں جیسے کارخانوں سے چھوڑا ہوا پانی اور بعض نامعلوم ذرائع ہوتے ہیں جیسے بارش کا پانی جو اپنے ساتھ مختلف قسم کی آلودگیاں سمیٹ لیتا ہے اور پھر پانی کے ذخائر میں شامل ہو جاتی ہے۔ پانی کو آلودہ کرنے کے ذرائع مندرجہ ذیل ہیں۔

- گھریلو اخراج:
- صنعتی فاضل مادے:
- کیمیائی کھادیں اور سپرے:
- تیل کی آلودگی :

- غلاظت اور کوڑا کرکٹ :
- گارکی آلودگی :
- آب و ہوا میں مختلف گیسوں سے پھیلنے والی آلودگی :
- تابکاری :

آلودہ پانی کے اثرات:

جب پانی مختلف ذرائع سے آلودہ ہو جاتا ہے تو اس کے برے اثرات تمام جاندار حیات پر ہوتے ہیں۔ آلودہ پانی کے اثرات درج ذیل ہیں:

۱۔ سیوریج میں موجود جراثیم اکثر و بیشتر متعدی امراض پھیلاتے ہیں جو کہ پانی کے استعمال کے ساتھ آبی و ارضی حیوانات کو بیمار کرتے ہیں۔ پانی کی جراثیمی آلودگی ترقی پذیر ممالک میں ایک بہت بڑا مسئلہ ہے۔ جہاں بچوں کی اموات کی بنیادی وجہ پانی سے پھیلنے والی بڑی بیماریاں جیسے ہیضہ اور ٹائیفائیڈ ہیں۔

۲۔ صنعتی فضلہ میں کچھ زہریلے مواد کا ہلکا اثر ہوتا ہے جبکہ بعض جان لیوا ثابت ہوتے ہیں کیونکہ وہ قوت مدافعت کے انسداد، تولیدی نقائص اور شدید بدہضمی جیسے اثرات مرتب ہو سکتے ہیں۔

۳۔ بعض جگہوں میں پانی میں سوڈیم فلورائیڈ ملا یا جاتا ہے کہ یہ دانتوں کے لیئے مفید ہے مگر تحقیقات سے ثابت ہوا ہے کہ انسانی صحت کے لئے ایسا پانی انتہائی نقصان دہ ہے۔ یہ انسان میں ہڈیاں ٹوٹنے کے خطرات کو بڑھاتا ہے۔ خراب صحت، بچوں میں دماغی نقص کا اضافہ کرتا ہے اور کینسر کے خلیوں کو بڑھاتا ہے۔

اللہ تعالیٰ نے اس زمین پر ہمیں صاف پانی مہیا کیا ہے لیکن یہ صاف پانی انسانوں کی وجہ سے آلودہ ہو رہا ہے۔ اندھا دھند صنعتی ترقی، گیس و کوئلہ کا استعمال، کیڑے مار ادویات اور انسانوں کی لاپرواہی کی وجہ سے پانی نہ صرف انسانوں کے لئے مضر صحت بن رہا ہے بلکہ پانی کے اندر اللہ تعالیٰ نے جو آبی حیات پیدا کی ہیں انسانی فائدوں کے لیے وہ بھی تباہ ہو رہی ہیں۔ پانی کے بغیر نہ اس زمین پر زندگی ممکن ہے اور نہ ہی انسانی غذائیت پوری ہو سکتی ہے۔ قرآن میں اللہ تعالیٰ کا ارشاد ہے:

ظَهَرَ الْفَسَادُ فِي الْبَرِّ وَالْبَحْرِ بِمَا كَسَبَتْ أَيْدِي النَّاسِ لِيُذِيقَهُمْ بَعْضَ الَّذِي عَمِلُوا لَعَلَّهُمْ يَرْجِعُونَ

“خشکی اور تری میں لوگوں کی بد اعمالیوں کے باعث فساد پھیل گیا۔ اس لئے کہ انہیں ان کے بعض کرتوتوں کا پھل اللہ تعالیٰ چکھا دے (بہت) ممکن ہے کہ وہ باز آجائیں۔”

پانی کو آلودگی سے بچانے کی اسلامی تعلیمات:

پانی اس زمین پر زندگی کی علامت ہے اس لئے اس کو آلودگی سے بچانا ہمارا فرض ہے۔ قرآن پاک میں اللہ تعالیٰ فرماتے ہیں:

كُلُوا وَاشْرَبُوا مِنْ رِزْقِ اللَّهِ وَلَا تَعْتُوا فِي الْأَرْضِ مُفْسِدِينَ ۗ“ اللہ کا دیا ہوا رزق کھاؤ پیو اور زمین میں فساد نہ پھیلاتے پھرو”

حضور ﷺ کا ارشاد ہے:

عن الرسول ﷺ “انہ نہیانیا لفي الماء الراكد

“رسول ﷺ نے ٹھہرے ہوئے پانی میں پیشاب کرنے سے منع فرمایا ہے”

ایک اور جگہ فرمایا: “قال اطفؤا المصابيح اذا رقدتم و غلقوا الابواب او كوا الماسقية و خمروا الطعام والشراب

“جب تم سونے لگو تو چراغ بجھا دو، دروازے بند کرو، مشکوں کے منہ باندھ دو اور کھانے پینے کے برتنوں کو ڈھانپ دو۔”

یہ حکم اس لئے فرمایا ہے کہ کہیں پانی میں آلودگی نہ چلی جائے، ہوا کے ذریعے کوئی کیڑا نہ گر جائے جو مختلف قسم کے وائرس منتقل کرتا ہو یا دوسری ضرر رساں بیماریوں کا سبب بنتا ہو۔

آلودہ پانی کی تحلیل و تطہیر کا سائنسی جائزہ:

زراعت میں سب سے پہلے گندے پانی کا استعمال آسٹریلیا، فرانس، جرمنی نے کیا۔ انیسویں صدی میں برطانیہ اور امریکہ نے بھی اس کا استعمال شروع کیا۔ اکثر ملکوں میں آلودہ پانی کی تطہیر کر کے اس کا دوبارہ استعمال نمایاں طور پر وسیع ہو گیا ہے جن میں اسرائیل، اردن، پیرو اور سعودی عرب بھی شامل ہے جہاں خاص طور پر کھیتوں کی آبپاشی کے لئے یہ پانی دوبارہ استعمال کرنا حکومتی پالیسی ہے۔ چونکہ بڑھتی ہوئی آبادی اور تیز ترین صنعتی ترقی کی بدولت پانی کے وسائل کا مطالبہ بڑھتا جا رہا ہے۔ پانی کے ذخائر زیادہ سے زیادہ بڑھانے کے لئے فضلہ پانی کا دوبارہ استعمال ایک جاذب نقطہ نظر بن چکا ہے۔

ضرورت اعتدال:

اسلامی تعلیمات تقاضا کرتی ہیں کہ زندگی اعتدال سے گزاری جائے، چنانچہ ارشاد باری تعالیٰ ہے:

وَكُلُوا وَاشْرَبُوا وَلَا تُسْرِفُوا ۗ وَلَا تُسْرِفُوا إِنَّهُ لَا يُحِبُّ الْمُسْرِفِينَ

جگہ فرمان الہی ہے:

اور حد سے تجاوز نہ کرو، اللہ حد سے تجاوز کرنے والوں کو پسند نہیں کرتا۔“

قرآن کی نظر میں ہر وہ چیز جو صلاح و درستگی سے دور ہو جائے اور نفع کی صلاحیت کو کھو دے وہ فساد ہے، اگرچہ اس کا غالب استعمال عقیدہ اور عمل کی خرابی کے لئے ہوتا ہے، لیکن کسی چیز کے نظام توازن اور اعتدال (Moderation) کو بگاڑنے پر بھی اس کا اطلاق ہوتا ہے، جس سے اس کی حقیقی افادیت آہستہ آہستہ ختم ہو جائے۔ چنانچہ ارشاد باری تعالیٰ ہے -

وَإِذَا تَوَلَّى سَعَىٰ فِي الْأَرْضِ لِيُفْسِدَ فِيهَا وَيُهْلِكَ الْحَرْثَ وَالنَّسْلَ وَاللَّهُ لَا يُحِبُّ الْفُسَادَ

“ اور جب وہ تمہارے پاس سے دور ہوتے ہیں تو ان کی ساری بھاگ دوڑ اس لئے ہوتی ہے کہ زمین میں فساد مچائیں اور کھیتی اور نسل کو تباہ کریں اور اللہ فساد کو پسند نہیں کرتا۔“

اللہ تعالیٰ نے اپنی معرفت، قدرت کا ملہ اور ربوبیت کی شناخت اور ادراک کے لئے دو سے زائد آیتوں کے اندر زمین، ہوا، پانی، زندہ اور مردہ مخلوقات، شجر، حجر، پہاڑ، سمندر اور دیگر عجائبات عالم میں غور کرنے کی دعوت دی ہے اور کائنات کے اس نظام توازن کی طرف اشارہ فرمایا ہے، چنانچہ ارشاد ہے: صُنِعَ اللَّهُ الَّذِي أَتَىٰ كُلَّ شَيْءٍ ۖ إِنَّهُ خَيْرٌ بِمَا تَفْعَلُونَ

“یہ اس اللہ کی کاریگری ہے جس نے ہر چیز کو محکم کیا ہے۔“

اور حضرت ابو امامہ رضی اللہ عنہ سے روایت ہے کہ رسول اکرم صلی اللہ علیہ وسلم نے ارشاد فرمایا:

“میرے نزدیک لوگوں میں سب سے زیادہ قابل رشک وہ مومن ہے جو معمولی حالت میں ہو، خوب نمازیں پڑھنے والا ہو، گمنام ہو، لوگوں کے اندر اس کا کوئی خاص اہتمام نہ ہو اور اس کی روزی (Live hood) بقدر حاجت ہو اور وہ اس پر صابر ہو۔

نیز آپ نے بقدر حاجت مال کو کامیابی کی علامت قرار دیا ہے۔

آپ ﷺ کے ارشاد سے یہ روشنی ملتی ہے کہ حرص و ہوس مذموم ہے اور ہر چیز میں اعتدال مطلوب ہے اور یہ ظاہر ہے کہ اگر اعتدال اور میانہ روی کے ساتھ دنیا ترقی کی راہ پر گامزن رہے تو نظام توازن بھی برقرار رہے گا اور ماحولیات کا بھی تحفظ ہوگا اور ساتھ ہی ترقی بھی حاصل ہوتی رہے گی۔

کائنات کے تمام اجزاء، روشنی، ہوا، پانی، مٹی، چٹانیں، عناصر، نباتات و حیوانات وغیرہ اپنے اندر کچھ مقاصد اور فوائد رکھتی ہیں اور حضرت انسان شعوری اور غیر شعوری طور پر ان سے اس طرح مستفید ہوتا ہے کہ اس کی حیات و ممت ان پر منحصر ہے، ان کی عدم موجودگی میں یا ان سے کما حقہ استفادہ نہ کرنے یا ان کا استعمال غلط طریقے پر کرنے کی صورت میں خود انسان کی زندگی

خطرہ میں پڑجاتی ہے۔ اس لیے قرآن واحادیث میں ان مخلوقات کی اہمیت بیان کی گئی ہے، ان کی نشوونما اور ان کی حفاظت کی ترغیب دی گئی، انہیں بلاوجہ نقصان پہنچانے کی ممانعت وارد ہوئی ہے، انسان کی یہ بھی ذمہ داری ہے کہ وہ حتی المقدور ان مخلوقات کی بقا اور ان کی نشوونما کے لیے کوشاں بھی رہے۔

ایندھن، شعائیں، دھواں، غلاظت، فضلات، وغیرہ ماحول کو متاثر کرتے ہیں، کچرے کے ڈھیروں، فیکٹریوں، موٹر گاڑیوں سے خارج ہونے والے زہریلی گیس، اور بجلی کی پیداوار کے چند ذرائع بھی فضائی آلودگی میں اہم کردار ادا کر رہے ہیں۔ ایک محتاط اندازے کے مطابق موجودہ دور کی فضاء میں ۱۷۵۰ء کے نسبت ۳۱% زیادہ کاربن ڈائی آکسائیڈ جیسی مہلک گیسیں موجود ہیں۔

جب انسان اس آلودہ ماحول میں سانس لیتا ہے، تو اس وجہ سے وہ مختلف اقسام کی ذہنی و جسمانی بیماریوں سے دوچار ہوتا ہے، کینسر جیسی موذی بیماریاں اور پھیپھڑوں اور گلے کی پیچیدہ بیماریاں ماحولیاتی آلودگی کی پیداوار ہیں۔ بی الرجی، ذہنی تناؤ، سردرد، تھکاوٹ وغیرہ ماحولیاتی آلودگی کی وجہ سے ہیں۔

میسا چوسٹس انسٹیٹیوٹ آف ٹیکنالوجی سے وابستہ ماہر ماحولیات سٹیون بیرٹ کا کہنا ہے کہ گذشتہ ۵۰ برسوں کے اعداد و شمار سے ثابت ہے کہ شرح اموات میں اضافے کی بڑی وجہ فضائی آلودگی ہے۔ یو این او کے ایک ذیلی ادارے کے تحقیقی سروے کے مطابق دنیا میں ہر سال تیس ملین افراد صرف فضائی آلودگی کی وجہ سے پیدا ہونیوالی بیماریوں کی وجہ سے مرتے ہیں۔ اس لیے ماحولیاتی آلودگی ایک بین الاقوامی مسئلہ بن گیا ہے، جس کے حل کے لیے حکومتیں اور متعلقہ ادارے متفکر ہیں۔

پانی کی ضرورت سے زیادہ ذخیرہ اندوزی سے پرہیز:

اسلام کی ایک تعلیم یہ ہے کہ پانی کی ضرورت سے زیادہ ایسی ذخیرہ اندوزی نہ کی جائے کہ دوسرے لوگ تنگی میں پڑجائیں، چنانچہ آپ نے ارشاد فرمایا:

”مسلمان تین چیزوں میں شریک ہیں، پانی، گھاس اور آگ۔“

پانی ضائع کرنا درست نہیں ہے:

پانی زمین پر موجود ہر زندہ شے کی زندگی اور بقا کے لئے اولین ضرورت ہے۔ چنانچہ ارشاد باری تعالیٰ ہے:

وَجَعَلْنَا مِنَ الْمَاءِ كُلَّ شَيْءٍ حَيٍّ أَفَلَا يُؤْمِنُونَ

”اور ہم نے پانی سے ہر جاندار چیز کو بنایا ہے، کیا پھر بھی ایمان نہیں

لاتے۔“

پانی کی اہمیت کے پیش نظر اللہ تعالیٰ نے کرۂ ارض پر تین حصے پانی اور ایک حصہ خشکی رکھا ہے، چنانچہ کرۂ زمین پر ایک ارب چالیس کروڑ مکعب کلومیٹر پانی موجود ہے، اس کا ۱۷ فیصد حصہ سطح زمین پر ہے، لیکن ۹۷ فیصد زمین کا پانی سمندروں کی شکل میں ہے، جو زمین کے تقریباً ۸۶۷۰ فیصد رقبہ پر پھیلا ہوا ہے، اور جو نمکین اور انسان کے لئے ناقابل استعمال ہے، انسان کے لئے قابل استعمال پینے اور دیگر استعمالات کے لئے صرف تین فیصد پانی ہی دستیاب ہے، جس کو ہم تازہ پانی کہتے ہیں۔ میٹھا اور قابل استعمال پانی، برفانی تودوں یا عمیق برف کی چادر کی شکل میں قطبین (Poles) پر ہے برفانی پانی عموماً کسی بھی قسم کی آلودگی سے پاک ہوتا ہے، لیکن برفانی پانی کا تناسب صرف ایک فیصد ہے، اور دو فیصد میٹھا اور قابل استعمال پانی، دریائوں، ندیوں، نہروں، جھیلوں، تالابوں، کنوئوں اور کنٹوں سے حاصل ہوتا ہے۔ الغرض قابل استعمال پانی کی مقدار بہت کم ہے۔ لہذا پانی کی قدر و قیمت بہت زیادہ ہے، جس کے پیش نظر اسلام کی تعلیم ہے کہ اسے خواہ مخواہ ضائع نہ کیا جائے۔

رسول اللہ صلی اللہ علیہ وسلم نے فرمایا:

“اس امت میں کچھ لوگ ہوں گے جو طہارت اور دعا میں حد سے تجاوز کریں گے۔“

اس سے معلوم ہوا کہ پانی کو بلاوجہ استعمال یا ضائع کرنا، اس عظیم نعمت کی ناقدری ہے۔

پانی کو آلودہ کرنا درست نہیں ہے:

اسلام کی ایک تعلیم یہ ہے کہ پانی کو آلودہ نہ کیا جائے، کیونکہ پانی تمام جاندار اجسام کی زندگی کا دارومدار ہے اور طبی نقطہ نظر سے زندہ جسم میں پانی کی کارکردگی کا حصہ دوسری چیزوں کے مقابلے میں ۹۰ فیصد زیادہ ہے، غذا اور ہوا بھی پانی ہی کے ذریعے جسم میں تحلیلی عمل سے گزرتی ہیں، بلکہ جسم کے ظاہر و باطن سے نقصان دہ عناصر کو دور کرنے کے لئے بھی پانی کی کارکردگی اہمیت رکھتی ہے، جب کہ دوسری طرف یہ بھی حقیقت ہے کہ پانی ایک آفاقی محلول (Solution) ہے، جس میں کوئی بھی آلودہ ہوجاتا ہے، آج پانی کی آلودگی سب سے اہم اور بڑا مسئلہ ہے، چنانچہ فضائی آلودگی کے بعد آبی آلودگی (Water Pollution) ماحولیات کا سب سے سنگین مسئلہ بن گیا ہے۔

پانی کو آلودگی سے بچانے کے لئے اسلام نے سب سے زیادہ موثر اور منصفانہ تعلیمات دی ہیں، ان ہی میں سے ایک تعلیم یہ ہے کہ ٹھہرے اور بہتے ہوئے پانی دونوں میں پیشاب اور پاخانہ کرنے سے بچا جائے، اس لئے کہ پیشاب اور پاخانہ

پانی کی آلودگی کے خطرناک ترین اسباب میں سے ہیں، کیونکہ ان کے سبب سے کالرا، ٹائفاڈ اور سوزش جگر و معدہ جیسے بہت سے امراض پیدا ہوتے ہیں، چنانچہ سرکارِ دو عالم صلی اللہ علیہ وسلم نے ارشاد فرمایا:

“تین لعنت کا سبب بننے والی جگہوں سے بچو (۱) پانی کے گھاٹ پر پاخانہ کرنے سے (۲) راستہ میں پاخانہ کرنے سے (۳) سایہ دار جگہوں میں پاخانہ کرنے سے۔“

گھاٹ یا نہر، نالہ اور ندی کے کنارے رفع حاجت کی ممانعت کی وجہ یہ ہے کہ نجاست کے اثرات پانی میں پہنچ کر اسے آلودہ کر دیں گے۔

اسی طرح نبی کریم صلی اللہ علیہ وسلم نے ٹھہرے ہوئے پانی میں پیشاب کرنے کی ممانعت فرمائی، جیسا کہ ارشاد ہے:

“تم میں سے کوئی اس پانی میں پیشاب نہ کرے جو ٹھہرا ہو، پھر اس میں غسل کرے۔“

چونکہ ٹھہرے ہوئے پانی میں آلودگی پیدا ہونے کا زیادہ امکان ہے، لہذا خاص طور سے اس کا ذکر فرمایا اور بہتے ہوئے پانی میں پیشاب کرنے کی صریح ممانعت بھی وارد ہے جیسا کہ حضرت جابرؓ سے روایت ہے کہ: نبی کریم صلی اللہ علیہ وسلم نے بہتے ہوئے پانی میں پیشاب کئے جانے سے منع فرمایا۔ ”الغرض ان احادیث پاک کا مفہوم یہ ہے کہ ایک عقلمند انسان ایسا کیوں کر کر سکتا ہے کہ اس پانی میں پیشاب کرے، جس پانی کا وضو اور غسل وغیرہ میں وہ محتاج ہے۔“

طبی اعتبار سے پانی میں پیشاب کرنے سے ”بلہارزیا (Bilharzia)“ نامی مرض کے جراثیم پانی میں پھیل جاتے ہیں اور خاص طور سے ٹھہرے ہوئے پانی میں، پھر وہ اپنے تکوینی مراحل طے کر کے دم دار جرثومہ کی شکل میں پانی میں تیرنے لگتے ہیں اور جب اسے کوئی جسم مل جاتا ہے تو وہ اس کے اندر گھس جاتے ہیں اور سوزش جگر وغیرہ مختلف بیماریوں کا سبب بن جاتے ہیں۔

حالت جنابت میں ٹھہرے ہوئے پانی میں غسل کی ممانعت:

پانی کو آلودگی سے بچانے کے لئے اسلام کی ایک تعلیم یہ ہے کہ جنابت کی حالت میں ٹھہرے ہوئے پانی میں غسل نہ کیا جائے، بلکہ باہر رہتے ہوئے پانی لے کر غسل کرے، جیسا کہ حضرت ابوہریرہؓ سے روایت ہے کہ نبی کریم صلی اللہ علیہ وسلم نے ارشاد فرمایا:

”تم میں سے کوئی جنابت کی حالت میں ٹھہرے ہوئے پانی میں غسل نہ کرے، کسی نے پوچھا: اے ابوہریرہ! تو کس طرح غسل کرے تو انہوں نے جواب دیا: باہر رہتے ہوئے پانی لے کر غسل کرے۔“

اور اس حالت میں پانی میں داخل ہو کر غسل کرنے کی ممانعت محض اس وجہ سے ہے کہ پانی آلودہ نہ ہو، خواہ پانی کثیر ہی کیوں نہ ہو۔

نیند سے بیدار ہو کر برتن میں ہاتھ ڈالنے کی ممانعت:

اسلام کی ایک تعلیم یہ بھی ہے کہ نیند سے بیداری کے وقت ہاتھ دھوئے بغیر برتن میں ہاتھ نہ ڈبوئے، کیونکہ میلے ہاتھ پانی کو آلودہ کر سکتے ہیں، چنانچہ حضرت ابوہریرہ سے روایت ہے کہ رسول کریم صلی اللہ علیہ وسلم نے ارشاد فرمایا:

”جب تم میں سے کوئی اپنی نیند سے بیدار ہو، تو وہ اپنا ہاتھ برتن میں نہ ڈبوئے، یہاں تک کہ اسے دھولے، کیونکہ اسے معلوم نہیں کہ اس کا ہاتھ جسم کے کس حصہ پر پڑا۔“

یعنی سونے کی حالت میں ہاتھ انسان کے مختلف حصوں پر پڑنے کی وجہ سے آلودہ ہو جاتا ہے۔

پانی کو آلودگی سے بچانے اور انسان کی سلامتی اور صحت کے تحفظ کی خاطر، اسلامی شریعت نے ہر اس بے احتیاطی پر قدغن لگایا ہے جس سے پانی کے آلودہ ہونے کا اندیشہ ہو اور ہر اس حسن تدبیر کا حکم دیا ہے جو پانی کو آلودگی سے محفوظ رکھے، چنانچہ اس سلسلہ کی ایک تعلیم یہ ہے کہ پانی یا دیگر مشروب کے برتن کو ڈھانک کر رکھا جائے، جیسا کہ حضرت جابر بن عبد اللہ سے روایت ہے کہ رسول کریم صلی اللہ علیہ وسلم نے ارشاد فرمایا:

”برتن کو ڈھانک دو، اور مشکیزہ کے منہ کو بند کر دو اور دروازہ لگادو، اور چراغ کو بجھا دو، کیونکہ شیطان مشکیزہ کو نہیں کھولتا ہے، اور نہ ہی دروازہ کو وا کرتا ہے اور نہ ہی برتن کو کھولتا ہے، سو اگر تم میں سے کوئی ڈھانکنے کی کوئی چیز نہ پائے، مگر یہ کہ اپنے برتن پر چوڑائی میں لکڑی رکھ دے اور اللہ تعالیٰ کا نام لے، تو وہ ایسا ہی کر لے۔“

پانی کو آلودگی سے بچانے کے لئے اسلام کی ایک تعلیم یہ ہے کہ پینے کے برتن میں سانس نہ لی جائے، چنانچہ حضرت قتادہ سے روایت ہے کہ نبی اکرم صلی اللہ علیہ وسلم نے برتن میں سانس لینے سے منع فرمایا۔

اور ممانعت کی وجہ ظاہر ہے اور وہ یہ کہ برتن میں سانس لینے یا پھونک مارنے کی صورت میں اندیشہ ہے کہ تھوک اور منہ کی تری سے کچھ ظاہر ہو کر پانی میں گر جائے، اور یہ بھی ہو سکتا ہے کہ کسی پینے والے کے منہ میں بدبو

ہو جو پانی کے لطیف ہونے کی وجہ سے اس کے ساتھ چپک کر گھل مل جائے اور اس طرح پانی آلودہ ہو کر متغیر ہو جائے اور طبیعت سلیمہ کو اس کے استعمال سے تنفر ہو۔

نتائج بحث :

پانی کی اسی اہمیت کے پیش نظر اللہ تعالیٰ نے کرہ ارض پر تین حصے پانی اور ایک حصہ خشکی رکھا ہے، چنانچہ کرہ زمین پر ایک ارب چالیس کروڑ مکعب کلومیٹر پانی موجود ہے، اس کا ۱۷ فیصد حصہ سطح زمین پر ہے، لیکن ۹۷ فیصد زمین کا پانی سمندروں کی شکل میں ہے، جو زمین کے تقریباً ۸۷۰ فیصد رقبہ پر پھیلا ہوا ہے، اور جو نمکین اور انسان کے لئے ناقابل استعمال ہے، انسان کے لئے قابل استعمال پینے اور دیگر استعمالات کے لئے صرف تین فیصد پانی ہی دستیاب ہے، جس کو ہم تازہ پانی کہتے ہیں۔ میٹھا اور قابل استعمال پانی، برفانی تودوں یا عمیق برف کی چادر کی شکل میں قطبی پر ہے برفانی پانی عموماً کسی بھی قسم کی آلودگی سے پاک ہوتا ہے، لیکن برفانی پانی کا تناسب صرف ایک فیصد ہے، اور دو فیصد میٹھا اور قابل استعمال پانی، دریاؤں، ندیوں، نہروں، جھیلوں، تالابوں، کنوئوں اور کنٹوں سے حاصل ہوتا ہے۔ الغرض قابل استعمال پانی کی مقدار بہت کم ہے۔ لہذا پانی کی قدر و قیمت بہت زیادہ ہے، جس کے پیش نظر اسلام کی تعلیم ہے کہ اسے خواہ مخواہ ضائع نہ کیا جائے۔

Islamic Perspective on Climate Change, pollution & Water management

Sharafat Ali Khan⁷⁹

Abstract

We live in a postmodern period where people face rapid changes in every sphere of life. Though there are many facilities available for the privileged individual in society nevertheless there are common challenges for the whole living creature on earth. Among them the challenge of climate change, pollution and water Management is on top. These environmental issues are more life-threatening for every living creature on earth as UN Secretary-General António Guterres shared this alarming situation in a press release in September 2022:

“Floods, droughts, heatwaves, extreme storms and wildfires are going from bad to worse, breaking records with alarming frequency. Heatwaves in Europe, Colossal floods in Pakistan, Prolonged and severe droughts in China, the Horn of Africa and the United States. There is nothing natural about the new scale of these disasters. They are the price of humanity’s fossil fuel addiction.

The World Health organization released a statement on November 7, 2022, in Europe climate change and air pollution kill an estimated 550 000 people in our Region each year out of a global estimated total of 7 million. So, this is our individual duty to save humanity from this big loss. In a recent report from September 2022, the World Bank reported there are 6.4 million deaths every year, caused by air pollution and climate change. About 95% of these deaths occur in developing countries. The cost of the health damage caused by air pollution amounts to \$8.1 trillion a year, equivalent to 6.1% of global GDP. Islam has a universal message for whole humankind for peace and development and our Last Prophet Muhamad Peace be upon him was sent by Almighty Allah as RahmatulilAlamin (Blessing for the whole world). In this connection, the Holy Quran says "And **whoever saves a life it is as though he had saved the lives of all mankind**" (5:32). This paper will discuss the Islamic perspective on climate change, pollution & water management using primary sources like verses from the Holy Quran, and Ahadith traditions and will suggest suggestions from an Islamic perspective to minimize the said issue.

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Growing Problems of Global Environmental Pollution

and Islamic Teachings: An Analytical Study

Khadijat Ul Kubra, Rida Ul Hasanat⁸⁰

Abstract

At this time, the problem of environmental pollution is becoming serious for the nations, the only reason for which is that humans have neglected the environment in the race for development thanks to science and technology in various areas of life and indulged in luxury. , the desire to gain wealth and profit by any means and to increase production at an unnaturally rapid rate, and to prioritize personal desires over the interest of society and quick gains over long-term gains, has become its mode. Due to which, undesirable and inappropriate changes have occurred in the physical, chemical and biological properties of air, water and land and the temperature of the earth has increased to a harmful extent, due to which the problem of global warming has arisen. Therefore, these changes have threatened the lives of humans and other living beings and there is a fear that their lives will end completely. While the environment is everything in which humans or other living things live. Therefore, land, forest, mountains, rivers, deserts, different types of living things such as humans, birds, insects and large animals and small living things are all essential components of the environment and all of them are necessary for each other in their natural life, but Now man has disrupted the interference in nature, due to which he causes air pollution, water pollution, land pollution, sound pollution, sea pollution. Pollution and radial pollution. There is a need now that in the light of Islamic teachings, effective measures should be taken to protect humans from the effects of environmental pollution so that humans can be protected from health hazards.

Keywords: Human, Air Pollution, Water Pollution, Land Pollution, Sound Pollution.

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Global Environmental Challenges: An Eco-Theological Response in Islamic Perspective

Dr Imran Baig Mirza⁸¹

Abstract

Poisonous and harmful substances are in abundance in the air, water, soil and human bodies due to human intervention and mismanagement of the resources of the earth, thus making future of both human beings and the planet vulnerable. Many of the environmental pollutions are interlinked beyond geographical boundaries thus require a global cooperation and coordination to resolve them, attention require both at individual (personal and professional) but mainly at national level (political) like public awareness, good governance, nuclear disarmament and development of ecofriendly technology. Environmental challenge also deals with the production, consumption and exploitation of the resources needed for mankind. Since the establishment of nation-states and a rise in industrial revolution, governments are trying to provide maximum luxuries facilities to her citizens and most often ignore the cost and effects faced by their own citizens and their surrounding countries in terms of environment crises. Studies show that this is the result of maximization of profit, mass productions, capitalism, and a wrong perception of life, such matters need to be addressed for a supportive habitat for human beings and other species.

Religion fundamentally deals and address issues beyond boundaries and for mankind at large. This way it approaches the crises of environment not as an individual or national level but as a collective effort both in principles and strategies to make them social norms. Islam in a most comprehensive way teaches humanity about the concept of life and world simultaneously in a balanced manner stressing on the simple living, not a life of comparison but a life of contentment. In this paper an attempt will be made to understand different aspects of environmental challenges in relation with the Islamic perspective.

Key Words: Environment, pollution, earthly resources, concept of life, ecofriendly, eco-theology, industrial revolution, capitalism

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Water Pollution: Causes, Damages, Remedies and Solutions (In the light of Islamic Teachings and the Prophet's ﷺ Seerah)

Dr. Mohammad Islam⁸² Dr. Fazal Ahad⁸³ Dr. Janas Khan⁸⁴

Abstract

Today, as a result of various human actions, various types of environmental problems have arisen, due to which various types of environmental pollutions have arisen. Environmental pollution is the biggest problem and a huge challenge of the entire humanity in the present age. Due to these problems, human life is having a profound impact. One of these environmental pollutants is water pollution. Water on earth is a great blessing of Allah, without which no living being can survive. Allah Almighty has made water the cause of life and the source of life and has started life with it. Allah says that we have created every living thing from water. Similarly, it has been said in another place that Allah has created every living thing from water. The importance of water has been mentioned many times in the Holy Quran. There are mentions of rivers, seas and clean springs of water in several blessed verses of the Holy Quran. It can be automatically estimated; how much water is the great resource for human life. In the blessed sayings of the Holy Prophet, ﷺ, it is forbidden to pollute the water and it is emphasized to keep it clean. Islam has given us basic principles in this regard. Islam not only orders us to keep water clean and pure, but also prohibits us from using water resources unnecessarily. Clean water is the urgent need of the hour. Therefore, special attention should be paid to the cleanliness of the environment, so that our water resources are not polluted and these resources are saved from being destroyed and wasted and can be used by future generations as well. Therefore, in this research article, water pollution, its causes and damages will be specially reviewed and an attempt will be made to present a scientific and research discussion on the solution and remedy of this important problem of the present age in the light of Islamic teachings and the Prophet's ﷺ Seerah.

Key Words: Water Pollution, Islamic Teachings, Seerah of the Prophet's ﷺ, Cleanliness, Future generations etc.

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آبی ماحول کا تحفظ اور احکامات: آیات و احادیث کے تناظر میں تحقیقی جائزہ

ڈاکٹر حافظ محمد حسین⁸⁵

اس میں کوئی شک نہیں کہ انسانی اور حیوانی زندگی کا دار و مدار پانی پر ہے۔ اس لیے کہا جاتا ہے کہ " پانی ہے زندگی " اور ہم اپنے حالات کے لحاظ سے جس طرح ماحولیاتی آلودگی اور فضائی آلودگی کا شکار ہیں اسی طرح آبی آلودگی سے بھی بڑی حد تک متاثر ہیں۔ یہ آبی آلودگی نہ صرف آبی حیوانات کے لیے تباہ کن ہے بلکہ اس کے اثرات انسانی زندگی کے لیے بھی خطرناک ہیں۔ آبی ماحول کا تحفظ بہت زیادہ ضروری ہے اور آبی ماحول سے مراد ہے پانی اور پانی کا ماحول اور اس سے مطلقہ چیزیں ہیں۔ لفظ آبیہ آب بمعنی پانی سے ہے پانی سے متعلقہ اشیاء جاندار، آلودگی اور ماحول و غیرہ آبی کہلائیں گی۔ ماحول کا لفظ گھر، حالت، زندگی اور کسی جگہ کو مسکن بنانے کے لیے بولا جاتا ہے۔ ماحول کے لیے انگلش میں لفظ Environment اور عربی میں "بیئۃ" کا لفظ استعمال ہوتا ہے۔ دوسری طرف جس طرح ربانی ہدایات اور نبوی تعلیمات ہمیں طہارت اور نظافت کا درس دیتی ہیں بالکل اسی طرح یہ تعلیمات آبی طہارت کو بھی مستلزم ہیں۔ اس لیے کہ پانی طہارت اور پاکیزگی کا ذریعہ ہے اور اگر آلہ طہارت ہی پاکیزہ نہ ہو تو اس سے کوئی اور چیز کیونکر پاک ہو گی۔

اب ضرورت اس امر کی ہے کہ ہم من حیث القوم شعوری طور پر آبی آلودگی کے نقصانات کو سمجھیں، اس ضمن میں نبوی تعلیمات کو سمجھیں اور قرآن کریم کی آیات اور احادیث طیبہ کی روشنی میں اس آلودگی کے سدباب کا اہتمام کریں۔ اسی تناظر میں زیر نظر تحقیق پیش خدمت ہے جس میں آبی آلودگی کا مفہوم، اس کی مختلف صورتیں اور ان صورتوں کا حکم سیرت طیبہ اور قولی و عملی احادیث کی روشنی میں پیش کیا گیا ہے۔

کلیدی الفاظ: آبی ماحول، پانی کی اہمیت و ضرورت، آبی ماحول کے تحفظ کے احکامات، آبی آلودگی کے نقصانات، ماحولیاتی اور فضائی آلودگی۔

اسسٹنٹ پروفیسر ویڈ، ڈیپارٹمنٹ آف اسلامک سٹیڈیز⁸⁵

Conservation of Water Resources in the Light of Quran and Sunnah: Benefits and Methods

ڈاکٹر محمد عمر فاروق

اللہ تعالیٰ نے قرآن کریم میں فرمایا ہے کہ " ہم نے ہر جاندار چیز کو پانی سے پیدا کیا ہے۔" (الانبیاء، آیت:30)، پانی کو اللہ تعالیٰ نے اپنی نعمتوں میں بطور خاص شامل فرما کر ہمیں اس کی قدر دانی کا حکم دیا ہے۔ سورۃ الملک میں ارشاد باری تعالیٰ ہے: "اے پیغمبر! آپ فرما دیجیے کہ ذرا سوچو! اگر تمہارا پانی گہرائی میں اتر جائے تو کون ہے جو لائے گا تمہارے پاس صاف نٹھرا ہوا پانی؟" (الملک، آیت:30) پانی جیسی نعمت اتنی وسیع اور عظیم ہے کہ وہ انسان کو زمین کی تہوں سے بھی عطا ہوتی ہے اور آسمان کی بلندیوں سے بھی۔ اللہ تعالیٰ ارشاد فرماتے ہیں: "کیا تم نے اس پانی پر غور نہیں کیا جو تم زندہ رہنے کے لیے پیتے ہو اور اس سے اپنی پیاس بجھاتے ہو، کیا تم نے اسے بادل سے اتارا ہے، ایساہر گز نہیں بلکہ ہم ہی اپنی قدرتِ کاملہ سے اسے اتارنے والے ہیں اور جب تم نے یہ جان لیا کہ ہم ہی اس پانی کو نازل کرنے والے ہیں تو صرف میری عبادت کر کے اس نعمت کا شکر ادا کیوں نہیں کرتے اور دوبارہ زندہ کرنے پر میری قدرت کا انکار کیوں کرتے ہو؟" (الواقعة، آیت:69) یہ پانی ہی ہے جو کہیں انسانی ضرورتوں کو پورا کرنے سے قاصر ہو جاتا ہے تو کہیں جل تھل ایک کر کے تباہی کی صورت پیدا کر دیتا ہے، تاہم اس سب اتار چڑھاؤ کے پیچھے قادر مطلق کا ایک نظام کار فرما ہوتا ہے۔ اللہ تعالیٰ حضرت نوح علیہ السلام کی قوم پر پانی کی صورت میں اترنے والے عذاب کی منظر کشی یوں فرماتے ہیں: "تو ہم نے زور کے بہتے پانی سے آسمان کے دروازے کھول دیے۔ اور زمین کو چشمے کر کے بہا دیا تو پانی اس مقدار پر مل گیا جو مقدر تھی۔" (القمر، آیت:12)

وطن عزیز اسلامی جمہوریہ پاکستان گزشتہ چند سالوں سے سیلابوں، بارشوں اور طوفانوں کی زد پر ہے۔ انڈیپنڈنٹ اردو کی رپورٹ کے مطابق: "دنیا بھر میں موسمیاتی تبدیلی کے باعث شدید متاثر ہونے دس میں سے سات ممالک کا تعلق اس خطے سے ہے اور اس پورے خطے میں پاکستان کے سب سے زیادہ متاثر ہونے کا خدشہ ہے جیسا کہ اس سال پنجاب میں کوئی شدید موسمیاتی واقعہ نہ ہونے کے باوجود بے موسم کی بارشوں نے زراعت کو شدید نقصان پہنچایا۔" پانی کے ان وسیع ذخائر کو زحمت سے رحمت میں تبدیل کرنے، مضر سے مفید بنانے، موت کی علامت کے بجائے زندگی کا سہارا بنانے میں انسان کا اپنا اختیار ہے۔ اگر وہ اللہ کی دی ہوئی عقل و تدبیر کو استعمال کرتے ہوئے آبی وسائل کی ذخیرہ کاری کر کے اسے موجودہ و آئندہ زمانوں کے لیے مفید تر بنائے تو وہ اللہ تعالیٰ کے اس عظیم عطیے کا دانشمندانہ حق ادا کرنے کے قابل ہو سکے گا۔ اس کی سب سے بہترین مثال حضرت یوسف علیہ السلام کے قصے سے ملتی ہے۔ انہوں نے بادشاہ وقت کے خواب کی تعبیر بتاتے ہوئے انہیں تلقین کی کہ فراوانی کے سات سالوں میں اگر تم قدرتی وسائل کا پوری منصوبہ بندی سے ذخیرہ کر لو گے تو اگلے سات سال جو سخت ترین قحط کے ہوں گے، تو تم اس کی مدد سے گزار لو گے۔ (یوسف، آیت: 47-49)

زیر نظر مقالے میں قرآن و سنت کی روشنی میں آبی وسائل کی ذخیرہ کاری کی حیثیت، تفصیل، منافع و مقاصد اور اس کے طریقہ ہائے کار پر بحث پیش کی جائے گی۔ جو بلاشبہ پوری دنیا کے ایک اہم ترین مسئلے کا تیر بہدف حل ثابت ہو گی۔

کلیدی الفاظ: آبی وسائل، قرآن و سنت، پاکستانی سیلاب، سورہ یوسف، عالمی موسمیاتی تبدیلیاں

اسلامی تعلیمات کی روشنی میں تحقیقی مطالعہ
Water Pollution and Human Responsibilities.

A research study from an Islamic perspective

Dr Syed Mujeeb Ur Rehman⁸⁶

Abstract

Water has three natural characteristics: color, taste and smell. Due to changes in these, the water does not remain compatible. Clean water has been described as a great blessing of Allah in the Holy Quran. Careless human behavior causes water pollution. Development of industry and increase in population are causing depletion of water resources and pollution of available water. Islam provides complete guidance to man about the resources and problems of living. In order to make water accessible to every human being, Islam declared it as a common asset of humanity. To protect its reserves from being wasted, The Prophet ﷺ has ordered to use water as needed in ablution and bath. To maintain its cleanliness, the Prophet ﷺ has issued various orders. Water pollution can be prevented by following these teachings of Islam. This paper discusses the human responsibilities to protect water from pollution from an Islamic perspective. In addition, it also describes the importance of water in human life from the Islamic point of view.

Key Words: Water, Pollution, Islamic Teachings

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اہمیت و قلتِ آب اور ہماری ذمہ داری : اسلامی تعلیمات کی روشنی میں محمد عثمان غنی⁸⁷

پانی انسانی معاشرے کا ایک لازمی جزو ہے۔ قرآن مجید میں اللہ تعالیٰ نے ہر جاندار چیز کو پانی سے بنانے کا ذکر فرما کر اس کی اہمیت کو مزید واضح فرمایا۔ پانی جتنا اہم ہے اتنا اس کا بے دریغ ضیاع بھی ہو رہا ہے۔ ایک وہ طبقہ ہے جو پانی کی ایک ایک بوند کو ترس رہا اور دوسرا وہ طبقہ جو بے دریغ پانی بہا رہا ہے۔ جس سے معاشرہ پانی کی قلت کا سامنا کر رہا۔ قلتِ آب سے بچنے کے لیے اسلامی تعلیمات ہمیں تو حوض پر بھی کم پانی کے استعمال کا سبق دیتی ہیں۔ زیر بحث عنوان میں پانی کی اہمیت اور موجودہ حالات میں پیش آمدہ اس کی قلت و کمی اور اس پر ہماری ذمہ داری شریعتِ محمدیہ ﷺ کی روشنی میں ذکر کیا جائے گا۔

کلیدی جملے: پانی، قلتِ آب، اسلامِ آلودگی، اسباب، نقصانات، تدارک اور حل (اسلامی تعلیمات اور سیرتِ نبوی ﷺ کی روشنی میں)

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7th

IWC POLICY RECOMMENDATIONS

Climate change has already caused significant damage, and adaptation measures are necessary to prepare for the future. Governments should develop policies to enhance resilience to climate change impacts such as floods, droughts, and heatwaves. This may include measures such as investing in infrastructure that can withstand extreme weather events, strengthening early warning systems, and improving disaster response.

In context with Climate change mitigation and adaptability program, National Determined Contribution (NDC) and Policy initiative at multiple levels require, Inclusive strategy, SDGs climate adaptation, Carbon Diplomacy and Regulation at Domestic, National and International Level and Green initiatives. Climate change is a global issue, and no single country can address it alone. Governments must work together to achieve global emissions reductions and increase support for developing countries to adapt to the impacts of climate change including Climate finance and carbon monetary mobilization schemes.

Renewable Energy Revolution with monitored carbon emission reduction and further Long-term Strategies for low emission target, moreover, Rational targets of GHGs emission reduction for industrial sectors with incentives and reward mechanism (legalized cap and trade system) for all industrial units and Introduction of fuel-efficient vehicle and machineries in industry and services need to be addressed.

Forestry, Agriculture productivity and climate restoration initiative, Fragile Ecological Sphere and Climate Security Conflict-affected areas and priority assessment have to be taken in to account.

Enhanced Transparency Framework and climate commitment at national, regional and international level, Paris Agreement and Net Zero Pathways Data Accessibility of Climate shifts with tracking system may be established at grass root level.

Responsive management and coastal assessment plan has to be focused on Coastal education, awareness and training for local citizens. Development of regional model of coastal and marine protection areas, Integration of local land use planning control in disaster risk reduction policy, Hydraulic monitoring of drains with digitalized performance measurement and establishment of high-water river training for this, Institutional capacity development at local level to be considered for an appropriate action.

Saltwater intrusion mitigation plan for the restoration of cultivable land and Mangrove's protection emergency plans with rigorous compliance is also a critical area of concern. Economic feasibility for the utilization of coastal resources may be developed for the blue economy.

Government may invest in research and development in renewable energy, energy efficiency, and sustainable agriculture, which will lead to innovative solutions and technologies that can help mitigate and adapt to climate change.

It is necessary to educate the public about the impact of climate change, causes, and potential solutions. Governments should support public awareness campaigns, education programs, and citizen engagement initiatives with the involvement of academia and civil society.

Government can encourage businesses and individuals to adopt climate-friendly practices by introducing economic incentives such as carbon taxes, subsidies for renewable energy, and green procurement policies. Climate financing is necessary to support developing countries to mitigate and adapt to climate change. Governments should work together to increase funding for climate change adaptation and mitigation measures in developing countries.

Glacial Lake Outburst Flood (GLOF)

GLOF risk reduction strategy may chalked out with advanced early warning system; Erections of artificial barriers on the sea floor by focusing on root cause analysis of hazard and GLOF susceptibility assessment system to divert the curse into blessing. Marking and zoning of GLOF- prone area to protect the infrastructure and livelihood; CO2 emission reduction policy implementation may be carried out.

In case of flood resilience and disaster risk reduction system, response mechanism for “Build Back Better” for 3R (recovery, rehabilitation and reconstruction) Coordinated tiers of inclusive governance with integrated disaster risk reduction policy and Inculcation of disaster/hazard mitigation planning in local planning on priority basis is the primary milestone to be followed. In addition to this, Construction of bridges and culverts with flood resistance design need to be developed.

Restoration toolkit for the local communities and radio communication system with proactive disaster warning system may be available. Governments should establish comprehensive disaster risk management plans that are tailored to local contexts and reflect the risks and vulnerabilities of communities. These plans should be regularly reviewed, updated, and communicated to all stakeholders to ensure effective response and recovery.

Governments should implement land use planning policies that prioritize sustainable and resilient development. This includes zoning and building codes that reduce exposure to flood hazards, preserving and restoring natural flood protection measures such as wetlands and forests, and promoting green infrastructure such as rain gardens and green roofs.

Governments should invest in early warning systems and emergency response infrastructure to enable rapid and effective response to floods. This includes building flood shelters and evacuation routes, providing access to emergency supplies, and establishing communication networks to alert residents of impending floods.

Governments should support community participation and empowerment in flood risk reduction efforts which may include; providing training and resources to enable communities to take a more active role in preparing for and responding to floods, and involving them in decision-making processes related to flood risk management.

Governments and international organizations should increase investment in disaster risk reduction, particularly in vulnerable regions. This includes investing in hazard mapping, risk assessments, and research to better understand flood risk and its impacts, as well as

supporting the development of financial instruments such as insurance and contingency funds to enable effective recovery and reconstruction after floods.

Governments and international organizations may facilitate the exchange of information and best practices, and support capacity building and technical assistance in countries and regions that are particularly vulnerable to floods.

Water Pollution & Waste Water Management

Integrated operational model of WASH and sanitation in lined with the socio-economic, political and behavioral adaptation with cooperative school of thought is to be pursued.

Hydro-emergency units/labs may be established and drinking water may follow the protocols /standards of safe drinking water before the supply to the communities.

Health care facilities may be equipped with controlled water points; Chlorine test kits should be distributed by the government; Risk assessments of Sanitation facilities at public places to figure out the contamination of drinking water regularly and waste management department need to be collaborated with water supply and drainage so the open defecated areas may be away from it.

Planning system and integrated water cycle management on standard principles of quality with participatory approach linked with rational model of decision making and mapping of restricted resources has to be designed.

Groundwater quality management standards and its monitoring need to be followed in accordance with the guidelines for the multiple use of water and the heavy metal tracing kits for quality assessment of drinking water at the household level is a primary action to be pursued.

Reservoir maintenance action plan with screening and storm water harvesting mechanism and its sustainability (allocation of storm water management officer with evidence–driven data) has to work out.

For the efficient system of waste water treatment, Installment of basic pollutant treatment unit for potable water at local/household level and Implementation scheme and monitoring of surface water treatment system, Market-oriented interest-driven strategies of all stakeholders (public and private partnership model) and for the Effluent treatment micro screening plants (biologically advanced technology) can achieve by setting plans and targets.

Eco-toilets and waste water recycling need to be encouraged at domestic level through research and development (biological organism).

Strengthening of environmental regulation mechanism manage the Defined role of CCI, provincial and federal authorities with check and balance to be account-far.Tax/reward/incentives/rebate system may be created for the industrial entrepreneurs for the green initiatives.

Digitalized waste water system is need of the hour with Integration of Artificial intelligence and IT based network by establishing data centers with real time GIS linked system.

Islamic perspective on Climate Change, Water Pollution & Water Management

The “Polluters-Pay Principle” may be applicable at various tiers and maintenance of wetland pollutants remedial strategy to be developed.

Inculcation of Islamic governance model in the water industry; "Rights for all" is a primary mission with balanced and equitable flow of resources may be incorporated in our water strategies.

Ecological sustainability with water demand management including “Rules of ijihad with 5 operational tools are "qiyas” (analogy), ijma (unanimous agreement of jurists), “istihsan” (juristic preference), “maslaha” or “istislah” (public interest or human welfare), and “istishab” (continuity or permanence)" may be operationalized.

Education and training system on WASH awareness in context with Islamic principles at school/day care centers may be launched. A comprehensive approach that involves cooperation, innovation, and sustained effort is necessary to address the challenge of Climate change by considering Islamic ethical values for the eco-system.

Water Governance and Institutional Capacity

Establishment of water metering and grading system for specific utilization is very much required along-with market and network of water governance in term of supply mobilization system. Further, Triple- loop model of hydro-governance on updated scale of trust and reciprocity, Polycentric mode of governance with congruence between appropriate and provision rules in accordance with the local conditions is to be pursued as well as collective Operational Rules for all provincial and federal authorities are the need of time.

Effective coordination among the Institutions to avoid duplication roles and responsibilities through Demand-centric model of water supply governance with the lens of policy shed approach is required. Establishment of Hydro-Network development to resolve the issue of; water inequity at head-tail level direct and capacity evaluation of Indus Basin irrigation system through cooperative approach between upper and lower riparian.

Ground Water Management

Strong enforcement mechanism of groundwater regulation and extraction permit system is a weakest area in Pakistan which need to be addressed.

Protective irrigation techniques in agriculture fields; Canal water supply on the basis of soil, cropping pattern and water availability and appropriate crop selection procedures according to the groundwater quality and agro-ecological zone to be chalk out.

Policy of subsidies to electric tube-wells need major improvement.

Water Technology

Installment of digitalized infrastructure in the irrigation, domestic and industrial sector to accommodate specific sectors of action with utmost reliability and Refurbishment of canal system and tributaries to minimize water losses.

Fit-for purpose, low cost innovation machinery to recycle water at domestic level; Deployment of in-situ sensors, predictive analytics and forecasting portal for government to take quick, evidence based decisions, DNA -fingerprinting mechanism to trace point\ nonpoint sources of water contamination, Mobile water governance & management platform to facilitate users in the case of billing and services, GIS and remote sensing for the mapping of resources should be promoted in the decision making at local level specifically (irrigation water management) .

Rain Water Harvesting Technique

Rainwater harvesting to be propagated with subsidy incentives to augment water supply and to reduce storm runoff.

Use of Gray water reclaimed water and rain-harvested; guidelines may be work out.

Message of the Director USPCAS-W Mehran University



Professor Dr. Rasool Bux Mahar
Director
U.S Pakistan Center for Advanced
Studies in water (USPCAS-W)
Mehran University of Engineering and
Technology Jamshoro Sindh

The 7th International Water Conference was a landmark event that left a lasting impact on the water sector. The conference attracted a broad range of participants from around the world, including leading academics, water management experts, policymakers, and representatives of various organizations.

One of the most significant outcomes of the conference was the exchange of ideas and experiences, which helped to broaden participants' perspectives on water management challenges and solutions. Through panel discussions, presentations, and workshops, attendees had the opportunity to learn about the latest developments in the field and share

their knowledge and expertise with others.

The conference also served as a platform for highlighting innovative approaches to water management, with many participants presenting cutting-edge research and case studies on sustainable water use. These presentations showcased the potential for new technologies and strategies to improve water efficiency and conservation.

Another important aspect of the conference was the networking opportunities it provided. Participants had the chance to meet and engage with colleagues from different countries and sectors, fostering new partnerships and collaborations that could lead to significant advances in water management.

Our center U.S Pakistan Center for Advanced Studies in Water (U.SPCAS-W) participated actively in the conference. From our center fifteen abstracts were presented which were solving water related issues from Environmental Engineering, Water Sanitation and health sciences, Integrated water resource management and Hydraulics, irrigation and drainage areas.

Overall, the 7th International Water Conference was a highly successful event that contributed significantly to advancing the global agenda on sustainable water use. By bringing together a diverse range of stakeholders and promoting knowledge-sharing and collaboration, the conference helped to build momentum towards a more sustainable and equitable water future for all.

Message of the Head of Center for Climate Research and Development (CCRD), Comsats



Prof. Dr. Athar Hussain,
Head CCRD Comsats

Essentially all the recent published works and reports related to state of climate of Pakistan are indicative of the fact that the climate of Pakistan is changing its manifestations including the more frequent occurrence of extreme weather events, resulting in heat waves and floods. This tendency is witnessed in Summers of 2019 and 2022 in Pakistan, as well as globally too. The current rate of warming in Pakistan is about 0.34 degree Celsius per decade, when averaged over recent 30 to 35 years. This means that starting from year 2000, by 2030, a more than 1.0 degree Celsius warming is predicted. By same reasoning, a 3.5 to 4.0 degree Celsius warming is predicted by 2099. This clearly indicates an overshoot of temperature limits (relative to 1.5 to 2.0 degree Celsius), as suggested in Paris agreement at COP 21.

A more integrated and bottom-up approach is needed to address the various issues arising from such a high rate of warming in Pakistan. For comparison, the cumulative rest of world warming rate is somewhat lower than this one, for the same period. This 7th edition of Conference thus has the following four sub-themes: 1. Climate Change & Maritime Security, 2. Glacial Lake Outburst Flood (GLOF), 3. Water Pollution & Waste Water Management, 4. Islamic Perspective on Climate

Change, Water Pollution & Water Management. The above four sub-themes of this International Water Conference have rightly and timely addressed the selected issues since contemporary community-based solutions are always key to any adaptation and mitigation strategy against adverse consequences of regional change in climate.

Additionally, the changing precipitation patterns and rising temperatures in Pakistan are redistributing the occurrence patterns of vector borne diseases, including Dengue and Malaria. A northward moving tendency is noticed for both diseases, in Pakistan. The north west ward shift of monsoon in recent decades in Pakistan is also corroborating this tendency, as this shift contributes towards spatial re-distribution of freshwater resources. This is because of the availability of more favorable environment for mosquito larva to grow (temperature and humidity). These noticed tendencies require a carefully planned coordination between water resources management and health care providers, starting from grass root level.

Being from Climate Science community, through this gathering of Water experts, I would like to draw attention of all those concerned towards the fact that Pakistan still does not have a weather forecasting model nor a climate prediction model tuned specifically to address the peculiar geography induced factors causing uncertainties in weather forecasting and climate predictions of Pakistan. Having such tuned models will help us in reducing uncertainties that in turn have considerable economic impacts on all sectors of our society. The world around us has already realized significance of this resource development and have addressed it domestically and are benefiting from it.

Message of the Associate Professor Biological Sciences University of Baltistan



Dr. Ishtiaq Hussain
Associate Professor
University of Baltistan

It gives me immense pleasure to be part of this important event as an organizing member and also a keynote Speaker at the 7th International Water Conference held at Islamabad.

Water is a need connecting all aspects of life and human livelihood across the globe; hence its importance is incontrovertible. Both extremes of water availability (drought and flooding situation) not only affect daily life and biodiversity but also badly affecting the industry, agriculture and the economy too. On the other side its management and socio-hydrology at micro scale to immense water management practices is the dire need for sustainable development. Mountains are well known for water sources, with a momentous impact on a volume of water that flows to downstream areas feeding plain areas of Pakistan. Glaciers, snow and ice are the main source of fresh water. Gilgit-Baltistan, being the mountainous region possesses plenty of glaciers, snow covered mountains and natural spring, glacial lakes at high altitudes in the Karakoram and Himalayas, are famous as “Water Towers”. Some of the famous glaciers, including Baltoro Glacier, Batura, Hispar, Biafo and Siachen Glaciers are one of the longest glaciers in the world spanning more than 50 km are contributing the Indus River that feed most of the agricultural lands of Pakistan.

Pakistan economy is mainly dependent on agriculture, is mainly fed by the River Indus and the country’s best irrigation system (Indus Basin Irrigation System), is due to the plenty of water fed by the northern watershed belts, snow melt glaciers and their run off. And the agrarian economy is largely dependent on the availability of water hence sustainable development. Sustainable Development Goals (SDG’s) place great prominence on the water availability, life on land and below the waters, highlighting the importance of environmental aspect, safeguarding the water quality and health. Better and sustainable management practice always plays pivotal role in the society and there are many best examples found in Pakistan.

The northern Pakistan (Gilgit-Baltistan) has unique history and practices unique water management for urban and rural areas as well as for high altitude pastures. The Balti Royals (*Mindoq Rgyalmo*), who was the Rani of Sakardu built historically famous water Channel (Gangoopi) is still in use. The Yabgos of Khaplu Raja and Mondoq, constructed water channels, irrigating hundreds of acres in high altitude mountains without use of mechanized technologies and machineries. The local inhabitants of Baltistan have expertise to rear glaciers by a famous and unique traditional practice of “Glacier Grafting”.

Under UNDP project “GLOF-II”, the University of Baltistan is an academic partner, focusing on socio-economic development, revival of indigenous practices and KAP studies grafted glaciers in high altitude mountains and Ice Towers. Through these interventions it not only highlighted its importance but also gaining attraction and demand under water scarce areas of mountain areas. Through academic linkages and joint research, conferences; the importance and its significance would bring experts and researchers at one point to solve water associated problems, better water management practices,

sustainable approaches and green solution, hence the academic entities could achieve the targets underlying key factors of SDG's on changing climatic scenario.

Our partnership with national and international organization, academic institutes and research organization across Pakistan not only strengthen the

research and development and providing platform for students but also enables policy makers to come forward and play their role to uplift the national economy and food security.

