WORLD WATER DAY
MARCH 2022

on the theme of
Ground Water Making Invisible – Visible

Celebrated by
PAKISTAN ENGINEERING CONGRESS

PAKISTAN ENGINEERING CONGRESS
(4th Floor) Pakistan Engineering Congress Building,
97-A/D-1, Liberty Market Gulberg-III, Lahore 54660
(Near Liberty Roundabout)
Phone: (042) 35784238, (042) 35784235 Fax: (042) 35784236
Web-site: www.pecongress.org.pk
E-mail: info@pecongress.org.pk

ON BEHALF OF PAKISTAN ENGINEERING CONGRESS

Pakistan Engineering Congress as a body does not hold itself responsible for the opinions expressed by different authors in this Volume

Compiled and Edited

By:

Engr. Husnain Ahmad

Vice President / Convener Symposium Committee

Published

By:

Engr. Nayyar Saeed

Secretary

Price Rs. 500/-
Members Free

Can be had at:

PAKISTAN ENGINEERING CONGRESS

(4th Floor) Pakistan Engineering Congress Building,
97-A/D-1, Liberty Market Gulberg-III, Lahore 54660
(Near Liberty Roundabout)
Phone: (042) 35784238, (042) 35784235 Fax: (042) 35784236
Web-site: www.pecongress.org.pk
E-mail: info@pecongress.org.pk
ISBN: 978-969-603-050-8

PAKISTAN ENGINEERING CONGRESS
THE EXECUTIVE COUNCIL FOR THE 77th SESSION

PRESIDENT
Engr. Najam Waheed

Immediate Past President
Engr. Amjad Saeed (President 76th Session)

VICE-PRESIDENTS

1. Engr. Husnain Ahmad
2. Engr. Riaz Ahmad Khan
3. Engr. Ch. Ghulam Hussain
4. Engr. Tariq Rashid Wattoo
5. Engr. Capt.(R) M. Qadir Khan
6. Engr. Ch. Muhammad Arif
7. Engr. Muhammad Usman
8. Engr. Nayyar Saeed
9. Engr. Ch. Muhammad Aamir Ali

OFFICE BEARERS

1. Engr. Nayyar Saeed	Secretary
2. Engr. M. Anwar Qaseem Qureshi	Joint Secretary
3. Engr. Jamil Ahmad Basra	Treasurer
4. Engr. Muhammad Ammar	Publicity Secretary
5. Engr. Anwar Ahmad	Business Manager
6. Engr. Dr. Muhammad Riaz	Chief Editor

EXECUTIVE COUNCIL MEMBERS

1. Engr. Khalid Javed
2. Engr. Iftikhar Ahmad
3. Engr. Iftikhar ul Haq
4. Engr. M. Anwar Qaseem Qureshi
5. Engr. Jamil Ahmad Basra
6. Engr. Muhammad Ibrahim Malik
7. Engr. Tahir Anjum Qureshi
8. Engr. Anwar Ahmad
9. Engr. Syed Nafasat Raza
10. Engr. Sheikh Muhammad Saeed Tahir
11. Engr. Muhammad Sharif Shah
12. Engr. Ali Arshad Hakeem
13. Engr. Dr. Muhammad Riaz
14. Engr. Muhammad Saeed
15. Engr. Dr. Muhammad Saeed
16. Engr. Faisal Shahzad
17. Engr. Dr. Javed Iqbal
18. Engr. Ayyaz Ahmad Rasheed
19. Engr. Rana Muhammad Yamin
20. Engr. Haider Ali
21. Engr. Muhammad Ammar

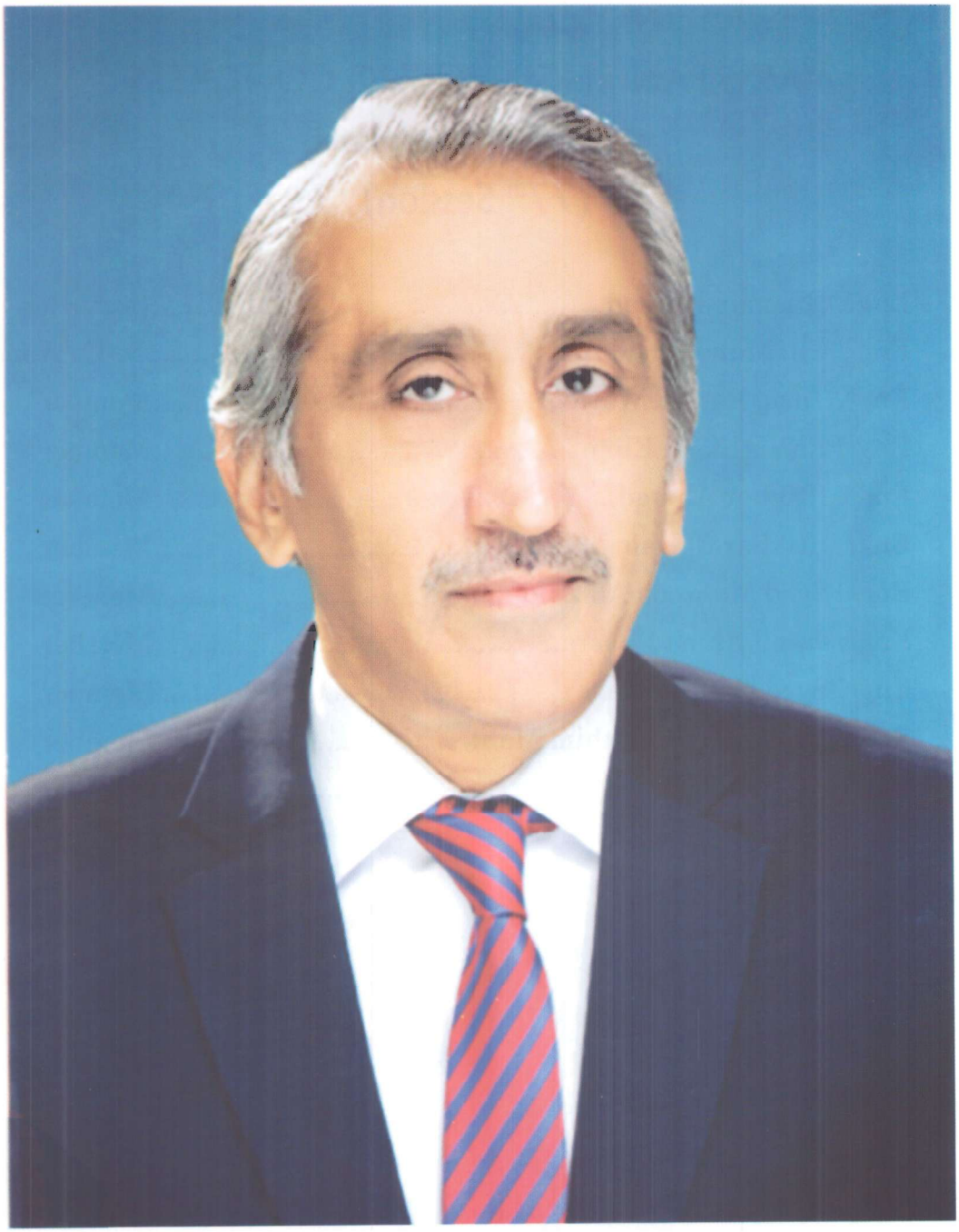
PROFILE OF PRESIDENT

Engr. Najam Waheed

Engr. Najam Waheed obtained his Bachelor's Degree from University of Engineering & Technology, Lahore in Civil Engineering. He has over thirty years of multifaceted professional experience leading and pursuing development and engineering projects which includes planning, project management, preparation of technical reports and contract documents. He is well-versed in various national and international codes, regulations, quality standards and their implementation. He worked on various prestigious and technically complex projects.

Engr. Najam Waheed has been a Council Member of Pakistan Engineering Congress for more than two decades. He has been an active member of the Congress serving as Secretary, Joint Secretary, Treasurer, and Convener of all important Committees of the Congress, and was elected as the President of the Pakistan Engineering Congress in December 2021. His vision has been manifested in a digital transformation of the Congress's services and has laid a strong foundation for future growth and developments of Engineers Communities.

His dedication to engineering development and the Pakistan Engineering Congress played a significant role in developing effective synergies with important professional bodies in the country, which would significantly contribute to engineers professional competence in a challenging environment of disruptive technologies and sustainable development.



Engr. Najam Waheed
President
Pakistan Engineering Congress
(77th Session)

PAKISTAN ENGINEERING CONGRESS

Symposium Committee

(77th Session)

1.	Engr. Husnain Ahmad	Convener
2.	Engr. Ch. Muhammad Arif	Co-Convener
3.	Engr. Tariq Rashid Wattoo	Member
4.	Engr. Riaz Ahmad Khan	Member
5.	Engr. Iftikhar Ahmad	Member
6.	Engr. Iftikhar ul Haq	Member
7.	Engr. Syed Mansoob Ali Zaidi	Member
8.	Engr. Jamil Ahmad Basra	Member
9.	Engr. Syed Nafasat Raza	Member
10.	Engr. Muhammad Ibrahim Malik	Member
11.	Engr. Anwar Ahmad	Member

TABLE OF CONTENTS

Paper No.	Title of the Paper	Author	Page No.
	The International Day of Forests and World Water Day 2022	Mahmood Akhtar Cheema Country Representative IUCN Pakistan	01
183	Situational Analysis of Water Resources of Karachi	Dr. Masood Arshad, Sohail Ali Naqvi, Ali Amjad, Muteeb Ahmad Sheikh	03
184	Sustainable Management of Groundwater at Ahmad Pur Lamma – Sadiqabad: An Isolated Freshwater Pocket used for Industrial Purpose	Zia-ul-Haq, Zamir Ahmad Soomro, Muhammad Dilshad Arshad, Muhammad Hassan, Faakhar Raza Muhammad Imran	11
185	Estimation of Invisible Groundwater Quality and Environmental Pollution Caused by Nitrogenous Fertilizers in Canal and Tube Well Irrigated Areas of Punjab-A Review	Abid Niaz, M. Akhtar, A. Kalsoom, Q.M. Akram, G. Rasul, H. T. Ahmad, M. S. A. Khan N.U. Ain	31
186	Treatment and Management of Brackish Water for safe use in Agriculture	Ghulam Murtaza, Ayesha Abdul Qadir, Tahir Shehzad, Zia Ur Rahman Farooqi	47
187	Food security and Groundwater Investment	Ghulam Nabi, Muhammad Masood, Muhammad Rashid, Umar Masood	61
188	An Invisible Threat to Deep Groundwater, Contaminants Assessment in Shallow Aquifers and Measures to Prevent Deep Aquifers Contamination in Central Punjab, Pakistan	Ali Muzaffar, Nawaz Salman, Mirani Bisharat Ali	73

189	Nuclear Energy: An Option for Greenhouse Gases Mitigation in Pakistan	Muhammad Saleem Ullah, Muhammad Imtiaz, Ijaz Ahmad	83
	Listing of Papers presented at various World Water Day(s) by Pakistan Engineering Congress		101

THE INTERNATIONAL DAY OF FORESTS AND WORLD WATER DAY-2022

By

Mahmood Akhtar Cheema

Country Representative IUCN Pakistan

An Overview of This Year's Theme

"Groundwater Making Invisible – Visible"

The International Day of Forests and World Water Day 2022, both days are equally important and both come together. It is evident that Forest and Water both are essential for life on earth. The theme for the International Day of Forests is: ***"Forests and sustainable production and consumption"*** and the theme for World Water Day is "**Groundwater: making the invisible visible**". The focus is on sustainability in both.

Pakistan is among the countries with very low forest cover and low per capita availability of water. Ample water and forests are very important for a sustainable future of any country. Realizing that, government agencies, donors, NGOs and corporate entities are working on numerous initiatives to enhance the forest cover and improve water resources in the country.

IUCN too is contributing through various projects towards enhancing the forest cover in the country as well as ecosystem restoration. One of its key projects is the Sustainable Forest Management (SFM) project which is funded by the Global Environment Facility (GEF) and is jointly implemented by the United Nations Development Programme (UNDP), the Ministry of Climate Change, IUCN Pakistan and the provincial Forest and Wildlife Departments of Khyber Pakhtunkhwa, Punjab and Sindh.

Serious efforts are also underway by the federal and provincial governments and other entities through the Ten Billion Tree Tsunami Programme (TBTTP). Numerous organizations have carried out mega plantation activities to reverse the situation in Pakistan by planting millions of trees all over the country.

The increasing role of the non-traditional players like Pakistan Navy and Private Sector entities towards afforestation is commendable. Pakistan Navy has planted around 7-million mangrove plants and the Karachi Conservation – a business and biodiversity platform established by IUCN comprising private sector companies - has planted one million mangrove plants in the near past, along coast in Sindh.

Theme for the World Water Day for this year is "**Groundwater: making the invisible visible**", The theme draws attention to the hidden water resource that has always been critically important but not fully recognized in sustainable development policymaking. Ground water depletion is a major concern and hence efforts are being made for ground

water re-charge. Pakistan has very high dependency on ground water for agriculture being an agriculture based country. Health of the ecosystem and forests is heavily dependent on the ground water.

Pakistan has the largest irrigation system in the world, however due to expansion in the agricultural lands and reduction in the water flow, the situation has worsened. Besides, in Balocistan IUCN has helped the communities in rehabilitation and restoration of Karezes that has worked well on drought resistance and salt tolerant varieties.

The *Adapting to Salinity in the Southern Indus Basin Project* is also working on the salt tolerant varieties in the salinity affected areas in Sindh.

Sea intrusion has made aquifers saline in the coastal areas of Sindh and Balochistan. IUCN has taken integrated measures under sea intrusion project, living with salinity and business and biodiversity projects to enhance vegetation and to improve water quality. The interventions are based on the nature-based solutions approach.

Pakistan Navy implemented a medium grant project in collaboration with IUCN, to pilot wastewater treatment system for reduction of coastal water contamination, under the Mangroves for the Future Programme. The system has the capacity to treat 30,000 gallons of wastewater per day. Pakistan Navy has replicated the model at its other units within Karachi.

With the increasing population and expanding industrialization the water consumption has increased manifold. There are reports from all over the country that the water table has dropped tremendously and in some areas it has gone down to a critically low level particularly in Balochistan. IUCN has conducted research on this issue and raised awareness to check and control ground water extraction. Pakistan is already in the water stressed zone that leaves no room for any irresponsible water extraction. There is an urgent need to change the agricultural practices and the water conservation based on the Integrated Water Resource Management system. Water is no more a free commodity and water use charges are important to make judicious use of this valuable resource.

The neighboring countries have strategically invested resources in enhancing the vegetative cover and improving their ground water resources to secure their future water needs and healthy ecosystems.

An ambitious initiative of Recharge Pakistan has also been launched by the federal government of Pakistan, with expectation to reverse the water situation in the country.

It is extremely important to build collaboration among the relevant institutions for effective implementation of existing policies and relevant forums need to be established to make these policies operational.

Both forests and water are essential for life, therefore, both need to be conserved and judiciously used for sustenance of ecosystems and livelihood of people.

THANK YOU

Paper No. 183

SITUATIONAL ANALYSIS OF WATER RESOURCES OF KARACHI

Dr. Masood Arshad, Sohail Ali Naqvi, Ali Amjad, Muteeb Ahmad Sheikh

SITUATIONAL ANALYSIS OF WATER RESOURCES OF KARACHI

By

Dr. Masood Arshad[1], Sohail Ali Naqvi[1], Ali Amjad[1], Muteeb Ahmad Sheikh[1]

Abstract:

The water supply of Karachi is dependent on surface water and groundwater sources. The groundwater provides water after the rainy season while remaining dry for the rest of the year. Moreover, the quality of groundwater in most of the parts is saline due to over extraction and sea-water intrusion. Unsegregated and untreated industrial and municipal wastewater is gathered through pipes and uncovered channels and drained through rivers and *nullahs* (streams). Recent studies suggest that population will grow by 30 per cent from 2017 to 2030. This will translate in an increased water demand which will in turn put pressure on the already scarce water resources. The situation of water in Karachi will continue to worsen if immediate steps are not taken to ameliorate the crisis. The research recommends the mitigatory, preventive and compensatory measures that can be adopted to alleviate the water and wastewater predicament.

Introduction:

The city of Karachi inhabits approximately 14.9 million people (Pakistan Bureau of Statistics, 2017). Housing almost 60 percent of the industries in the country, it is recognized as the industrial and financial center of Pakistan (IUCN, 2004). Its significance in Pakistan's economy is evident through the fact that it contributes 12-15 percent to the national Gross Domestic Product (Young, et al., 2018). Located on the coast of the Arabian Sea in the south of Pakistan, Karachi's water supply is dependent on surface water and groundwater sources. Surface water sources include Lake Haleji, Lake Keenjhar and Hub Dam while the groundwater source includes Dumlottee well-fields. However, the water supply from these wells is negligible, providing only 1.4 million gallon per day (MGD) of water after the rainy season. The wells are dry for rest of the year (JICA, 2008).

Methodology:

The study was conducted on the situational analysis of water in Karachi by collecting secondary data. For this purpose, stakeholders were involved and their reviews, experiences and suggestions were incorporated in the present study. An extensive analysis was conducted to gather water related data of Karachi. The study objects and framework drove the selection of methodology and instruments, as well as the extent of their implementation. The data's findings and analysis include details on water availability and management issues for industrial, institutional and home users, as well as potential hazards and organizational water management scenarios. The data offered in this study is expected to be useful to government entities, policymakers and other stakeholders.

[1] WWF-Pakistan

Water situation in Karachi:

Karachi Water and Sewerage Board supplies approximately 665 MGD to Karachi (Karachi Water and Sewerage Board, 2019), against a demand of 820-1200 MGD resulting in a shortfall of 155-535 MGD (World Bank Group, 2019). Approximately, 210 MGD of water supplied is not filtered (Karachi Water and Sewerage Board, 2019). Water Supply system of the city is at least 40 to 45 years old and an estimated 35 per cent of the supplied water is lost during transmission does thus decreasing the water availability 243 to 433 MGD. There is no metering for retail customers and only 25 per cent of commercial and industrial customers have a metered supply. Hence water consumption data for these sectors is not available. Almost 60 per cent of the houses are connected to the water supply network and water availability ranges from two hours after every two days to 2-4 hours every day. In order to fulfill the demand gap, Regulated and unregulated water hydrants are spread across the city. After the closing down of 948 unregulated water hydrants since 2009, 06 regulated and metered hydrant supply water to the city. Despite that, the issue of unregulated hydrants needs attention. K-IV Project phase- I, designed to supply an additional 260 MGD of water was to be completed by 2018, however only 20 per cent of the work have been completed till date (Express Tribune, 2019).

Groundwater in Karachi:

The water supplied to Karachi fails to meet the water demand of the city. Therefore, the use of groundwater has increased for certain domestic and industrial purposes within the city. The available groundwater resources are mostly saline in nature as the city is located near coastal belt and excessive extraction of groundwater has resulted in seawater intrusion into the available water aquifers located in the areas near the sea[1] . It is important to note that in order to maintain the recharge potential of an aquifer, there needs to be a balance between ground water extraction and recharge. Naturally, recharge occurs due to precipitation/rainwater via infiltration into the saturated zone. Annual rainfall in Karachi is 174.16 mm. Regrettably, Karachi lacks prominent rainwater harvesting schemes. Due to the poor infrastructure different parts of the city inundate with rainwater. Outdated storm water drainage system within the city results in urban flooding and the wasted rainwater.

Water Woes of Karachi:

Most of the surface and drinking water sources have levels of lead higher than the World Health Organization recommended value. A study in 18 towns of Karachi showed high levels of lead in 89 per cent of the samples. Pakistan council of research in water resources reports that 86 per cent of the water sources are contaminated with coliform and are considered unsafe for drinking. According to an estimate, less than 60 per cent people have access to sewerage facilities (Express Tribune, 2019) And almost 40 per cent of the city's population lives in slums with limited water supply and poor sanitary infrastructure. The sewerage system of Karachi consists of 5,670 kilometers of sewers six major pumping stations, 32 minor pumping stations and 250,000 manholes (KSWB,

---

1 Khattak, M. I., & Khattak, M. I. (2013). Ground water analysis of Karachi with reference to adverse effect on human health and its comparison with other cities of Pakistan. Journal of Environmental Science and Water Resources, 2(11), 410-418.

2019). A total of 475 MGD of sewage is generated in Karachi. Out of this, approximately 54 MGD is treated at Sewage Treatment Plant-1 site and sewage Treatment Plant-III, Mauripur while a third treatment plant remains non-functional. Over 12,000 industries of 65 different types exist in Karachi including tanneries, foundries, metal processors, manufacturers of plastic, rubber, glass, ceramics, tiles, cement, textiles, pharmaceuticals, soap, fish processing units, producers of fertilizers, pesticides and other chemicals. A combined Effluent Treatment Plant has been installed at Korangi Industrial Area, originally designed to treat wastewater from tanneries in the area and domestic sewage from KWSB Pumping Station-II. However, it does not run at full capacity and also receives waste from 280 or so other factories, affecting its performance. 420 MGD of untreated sewage (municipal and industrial) is disposed of into Lyari and Malir rivers, ultimately ending up in the Arabian Sea. This is causing coastal pollution and environmental degradation (Anon, 2000; Khattak et al, 2013). Due to changing climate conditions, torrential rains are becoming more common resulting in urban flooding. Lack of planning, ineffective drains and wastewater channels further aggravates the situation. There is a dire need to include storm water in the overall water management plan for Karachi.

What is at stake?

Population of Karachi increased from 9.339 million in 1998 to 14 9 million in 2017 showing a 62.5 percent growth in population in 19 years. Recent studies suggest that population will grow by 30per cent from 2017-2030 (EuroMonitor, 2018). This will translate in an increased water demand which will in turn put pressure only already scarce water resources. Water supply pipelines and sewage pipelines are corroded and often lie parallel to each other causing cross contamination. As a result, majority of Karachi does not receive safe and clean water and around 30,000 people, mostly children, die each year in the city due to consumption of contaminated water (Engel et al., 2011). Toxic effluents without any treatment are released by the industries into the natural water bodies of Karachi. This contaminates the surface and groundwater sources as well. Climate change poses a threat to the water scarcity of Karachi in the form of variable river flows due to change in rainfall pattern and rising of sea levels at the rate of 1.1 mm/year putting population residing by the water bodies at increased risk. Variation in rainfall patterns will also affect the Hub Dam, which is rain-fed, thereby creating a further uncertainty in Karachi's water supply. Water scarcity will severely affect the industries operating within the city. A recent report suggests that 300-400 industries in SITE Super Highway Industrial Area are on the verge of closure due to water scarcity (Express Tribune, 2018). Since retail customers are not metered there is very little conscious effort on their part to make responsible use of water and often large amount of water is wasted.

Recommendations:

It is recommended that following steps are taken in order to improve the worsening water condition:

- **Policy and regulations**

Sindh Environment Protection Agency should ensure the monitoring of wastewater being discharged from the industries and that it meets the Sindh Environment Quality

Standards 2016 guidelines. KWSB need restructuring and revamping in terms of its service delivery, governance structure, operations and infrastructure. This can be done by strong donor support and technical assistance in implementing the reform process. KWSB should ensure timely leak detection, repair and maintenance of pipelines and work towards dismantling the illegal hydrants in order to stop contamination, water loss and theft. Existing leaking pipes should be replaced with high density polyethylene pipes in the water supply infrastructure. Moreover, pumping efficiency needs to be improved and backup pumps need to be installed at the pumping stations.

KWSB should establish water quality labs at town level near water supply schemes for monitoring quality of drinking water before and after its supply to the people and results must be uploaded on various websites for public reference. Sindh Environmental Protection Agency (SEPA) should identify critical effluent discharge points in the surface water so that Lyari and Malir Rivers and the Arabian Sea can be protected from major contamination. Expedite completion of K-IV Project to ensure that water demand and supply gap is decreased. Also, areas where the water supply system is not available new distribution lines of water supply must be laid before the start of K-IV. Strong and effective storm water management plan is needed for the city as currently both major drains for the city namely Lyari and Malir rivers are badly affected due to pumping off solid waste. Government departments may extend financial support to promote research and innovation for the development of low cost, improved, resilient and environmentally friendly water and sanitation projects.

- **Water conservation through public awareness:**

The citizens of Karachi should use home-based cost-effective water purification and storage systems for example boiling, solar Disinfection, bio sand filters, flocculation and chlorination techniques. Water consumers and all stakeholders need to be educated regarding the responsible use of water so that water wastage can be minimized. In this regard, electronic, print and social media can play a vital role. Moreover, trainings on better water management practices should be conducted. In this case, NGOs and civil society can prove to be useful. Ensure that institutions at all levels teach about impending water crisis and the need to manage water resources sustainably. It can be done through lectures, seminars and workshops.

- **Use of smart environmental management practices:**

Industrial toxic wastewater contains heavy metals. It can be treated using financially viable and environment-friendly technologies. One such example is floating wetlands[1] which is effective and sustainable technology for industrial wastewater treatment. Textile industries in Karachi should consider compliance of Zero Discharge for Hazardous Chemical by 2020 as international buyers will actively start to pursue their suppliers for Zero Discharge for Hazardous Chemical. In addition, industries should be encouraged to conduct their audit in order to understand ways in which water consumption can be reduced. Not all industrial processes required potable water recycling gray water in

[1] Floating treatment wetlands (FTWs) or islands are small artificial platforms that allow these aquatic emergent plants to grow in water that is typically too deep for them. Their roots spread through the floating islands and down into the water creating dense columns of roots with lots of surface area.

industrial processes wherever portable water is not required can save fresh water. It can also be used to water gardens, flush toilets or any other non-portable use. Industries should focus on reducing pollution add source by using cleaner production techniques and reduce, reuse and recycle principles so that they produce less pollution load and save cost of its treatment.

Conclusion:

There is tangible evidence that the overall water situation in the country is deteriorating both in terms of quality and quantity. Karachi is the economic hub of the country and a significantly populated city. In order to retain its industrial productivity and meet the needs of its growing population, Karachi needs to understand and address its water issues through the aforementioned recommendations.

References:

- Pakistan Bureau of Statistics, 2017 Census
- IUCN. (2004). Sindh State of Environment and Development
- Young, W.J, Anwar, A, Bhatti T., Borgomeo, E., & Davies, S (2018). Pakistan getting more of water. World Bank Group.
- JICA (2008). The study on water supply and sewerage system in Karachi in the Islamic Republic of Pakistan (Vol 2).
- Karachi Water and Sewerage Board (KWSB). (2019).
- World Bank Group, 2019. Karachi Water and Sewerage Services Implement Project.
- World Bank Group (2018). Transforming Karachi into a Livable and competitive Megacity.
- Dawn, (2016). Tapping into Trouble.
- Express Tribune, (2019). Fate of K-IV and S-III Projects in doldrums.
- KWSB, (2019).
- N. Ul-Haq, M.A Arain, N. Badar, M. Rasheed, & Z. Haque (2011). Drinking Water; a major source of lead exposure in Karachi and Pakistan. Eastern Mediterranean Health Journal.
- EuroMonitor, (2018). Global Overview of Megacities.
- Engel, K., Jokiel, D., Kraljevic, A., Geiger, M., & Smith, K. (2011).
- Express Tribune (2018). 400 industrial units on verge of closure.
- Sindh Environmental Protection Agency, Statement showing details of Industries in Karachi having Wastewater Treatment Facility.
- Anon, (2002). Karachi Development Plan, United Nation Center for Human Settlements. UNDP Project Pak/80/019, Karachi Master Plan 1986-2000, p.20.