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WATER SCARCITY IN PAKISTAN: REASONS, IMPACT AND CURATIVE MEASURES

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Abstract *As the population is increasing at a very rapid rate in Pakistan which in turn results in a change of landscape depending on various geo-political factors, the existing water sources also become depleted simultaneously. There is no life without water on earth. There is a greater need for awareness to be raised, about the management of water resources to be utilized properly on a demand basis. This study highlights the major issues relevant to water, which is vital for drinking purposes, agriculture, and various other domestic purposes. One of the recommended methods of water preservation is proper maintenance of water channels whether run by private owners or by public companies with the involvement of the local community. Moreover, to be more accountable in terms of water utilization, an integrated mechanism for the distinction between drinking and general-purpose water is proposed to be devised. To increase storage capacity, the study suggests small dams instead of waiting anymore for the bigger dams to be constructed, to spread a network of water channels as well as automatically operated spill-over "bunds". The suggested measures are not only economical but also acceptable politically. In addition to extending riverbeds, storage stations should also be increased. To conserve the most vital natural commodity legislative measures should also be taken.*

Keywords*:* *Construction of water reservoir; Recommendation and way forward Water wastage; Water management; Water Scarcity Impact*

Introduction

Water scarcity is an inequity linking availability and demands, FAO (2010) and occurs whilst the requirement for water goes above the delivery, Molle and Molinga (2003). Falkenmark (1989) defined for the first time terms like water-stress as well as absolute water-scarcity based on the availability of water per individual. For this purpose, Falkenmark devised an indicator index which was later on called as "Falkenmark water-stress index". The index hereafter will be called Falkenmore index for easiness. It determines water-scarcity, water-stress, and "absolute water-scarcity" status at various stages/levels of handiness of water per individual. The Falkenmoreindex lies in the range between availability of water of 1000 -1700C^3 per person. This is the permissible threshold below which the limit of water-scarcity starts and goes down up to 500 C^3 per person. Further moving down this water-scarcity limit absolute water scarcity is encountered. Whenever a country's per capita water supply levels fall below the standard limit of 1000 C^3 then the country may rightly be called water scarce. Many researchers strongly recommended a benchmark value for the Falkenmore index to be 1000 C^3 to best understand and effectively utilize the concept of water-scarcity, water-stress and absolutely-scarce water conditions of any area within any country as well as several other countries around the globe, Muhammad (2011). Rapid population increases, advancement in standards of living in addition to different patterns of water consumption for irrigation are the main influential factors for the greater water demand globally. Many countries around the earth face moderate-severe scarcity of water for about more than half of the months around the year these include, the Western USA, some areas of Argentina and Chile, Northern Mexico, Somalia, North and South Africa, Pakistan, Middle Eastern Countries as well as Australia, Mekonnen and Hoekstra (2016).

Pakistan Water Resources

In Pakistan two types (natural and artificial) of water sources are found; artificial sources include rivers and rainfall water. The natural sources consist of wells, karez, streams, lakes, ponds, glaciers, rivers and rainfall, etc. The surplus water after all uses is collected in dams and barrages. This water is utilized for electricity production, irrigation, and day-to-day activities, Ayaz et al., (2007).

Rainfall

The Western Disturbances and Monsoons are the two main sources of rainfall in Pakistan. From July to September, about seventy percent of yearly Monsoon rainfall occurs in these months. Both zones arid and

semi-arid are found in Pakistan. Seasonal mean rainfall i.e., fifty-three millimeters occurred in the Rabi season, and two hundred- and twelve-millimeter rainfall occurred in Kharif season in the entire Indus plain. In Pakistan shifting from north and northeast the intensity of the condition is altered. During the summer and winter seasons it is the only region in the Khyber Pakhtunkhwa (Canal command areas) and Punjab (northernmost canal commands) that receives a sufficient amount of rainfall, Ayaz et al., (2007).

Glaciers

Pakistan has a huge collection and mass of glaciers in the world. The whole length of glaciers in the Karakoram Range is 160 km. European Alps has 22%, the Himalayas has 17% and about 37% of the Karakoram region is under its glacier. The upper Indus catchments glacier area is approximately 2250 km^2, which mostly comes from the majority of the river overflow in the hot period. In southern Hindukash the Unal Pass three thousand meters above sea level is the origination point of the Kabul River. After running in Afghanistan (eastern), the Kabul River welcomes into Pakistan through of Khyber Pass by the north side. The river Jhelum comes out from Kashmir at an inferior height than that of the River Indus, Ayaz et al., (2007). During winter the northern regions of Pakistan receive a snowfall. A huge amount of ice-melt water is released from the frozen reservoirs in the up-country to numerous main rivers. The glaciers (Table 1) comprise massive layers of ice and glacial lakes. In Pakistan the Himalayan-Hindu Kush area there has been a quick recoil of glaciers that has made extra lakes during the last few decades. These are happening due to the global warming effect that is increasing unabated as heat is projected more subsequently three to eight decades, WWF (2012).

Dams and Rivers

There are several rivers in Pakistan which finally join the Indus River. Sutlej, Jhelum, Chenab, Ravi, and Beas are the major five rivers that link the Indus River from the eastern part. While Siran, Soan, and Haro are the three small rivers. From the western side, the Indus River links with many minor rivers. In this category, the Kabul River is the largest, and further rivers are Kohat Tank, Tai, The GomalKurram, Kora, Punj, and Kunar from the right part, the Indus River links with some other small rivers, Ayaz et al., (2007). In Pakistan, the dam's historical background is comparatively low. There are only three (03) dams at the time of independence. One was located in Mianwali (Nomal Dam) constructed in the year of 1913. The other two dams located in Baluchistan water scare location i.e., Spin Karazi-1945 and Khushdil Khan Dam-1890, Ayaz et al., (2007). The dam's construction was started in Pakistan in 1955 when the state was facing severe power shortages and near Peshawar on the Kabul River Warsak Dam was constructed. Soon after India closed the water supply for Pakistan which distressed the system network of the canal. To restore the water for the affected canal system it is very significant to construct the big water storage reservoirs. For this purpose, the Mangla and Tarbela dams were built with storage capacity 5.88 MAF and 11.62 MAF, respectively. Apart from these dams, many other power dams and water supply reservoirs for irrigation were also recommended to be built, Ayaz et al., (2007).

Groundwater in Pakistan

Groundwater is another significant water source because it contributes about ninety-nine percent of freshwater around the globe. It is very difficult to estimate the exact capacity of Pakistan as far as groundwater is concerned. Moreover, an additional increase in groundwater of about 3-40% has been recorded during the period of the last four years. In Sindh province about twenty-eight percent of the area whereas in Punjab province 79% of the cultivated land depends on groundwater for life sustenance. The groundwater is mainly driven out in the form of tubewells and utilized for irrigation purposes. If the ground water source is salty then it is drained out and mixed with low salinity and clean canal water and then it is used for irrigation. In the period of last three decades especially in upper lying Indus plains the ground water has been utilized in irrigation canals in the areas where its quality is better than any other source of water for irrigation. In the early sixties, tube wells were used for land irrigation. Five lac (500,000) tube wells have been installed for irrigation in the areas of Indus Basin. In Pakistan, the total groundwater potential is 55 MAF, Ayaz et al., (2007). Groundwater reduction is taking place in numerous countries such as Saudi Arabia, Mexico, China, Iran, USA, India, and Pakistan, Mekonnen and Hoekstra (2016).

Three surface water hydrologic units are available in Pakistan: (i) Kharan Desert (ii) Makran Desert (iii) Indus Basin. Sixty-five percent of Pakistan is covered by Indus Basin and represents ninety-five percent of its water wealth. It comprises the Rann of Kutch area in addition to the Bahawalpur desert and Sindh desert, the Kacchi Plain, the mountainous regions of the north and the west, and the Indus Plain (Table 2). The only province is Balochistan which cannot get enough benefits from the Indus Basin due to its geographical locality and lying far away from the basin. Out of a total of eighteen rivers in Baluchistan, only seven are parts of the Indus basin. Among these Nari River ends in Hamal Lake in Sindh. Its water in no way reaches the Indus and the rest of the 06 rivers also contribute little quantity of water to Indus, Young et al., (2019). About seven rivers are flowing the Karan Coast basin located in Baluchistan (comprised of 18% of Pakistan territory) and four rivers in the desert of Kharan (17% of Pakistani area) lead towards Afghanistan and Iran. These later-mentioned rivers are lower in volume, and

irregular inflow; however, they have significant pollution caused in these basins which poses a threat to the organisms of the area. It is evident from Table 2 that groundwater has a smaller contribution as compared to surface water. Major groundwater sources of Pakistan lie in the areas of superficial alluvial formations and are located mostly near the Indus River. During ordinary weather conditions, the groundwater level regenerates when elevated river flow prevails and during drought, groundwater releases water back to the river when lower river flow prevails. Moreover, under ordinary climatic conditions, groundwater level is decreased by seepages and evaporation during surface water irrigation. Special attention should be given to underground recycling water from canals towards groundwater sources and to the non-ideal groundwater consumption and investigation of the real consumption value of these resources. Groundwater is an important water resource, but, even if most it finally originated from surface water extractions, Young et al., (2019). For Pakistan the three major hydrologic units show the highest natural water losses in arid as well as semi-arid areas, the reason for these losses, non-productive consumption in the forms of evaporation relevant to an irrigation system. Of all these resources only one-third of these water resources are consumed for useful purposes. Less than one-third of the total resource goes to beneficial consumptive use. In the Indus Basin and the Kharan Desert the sum of use and losses slightly exceeds total inflows and internal contributions, indicating groundwater depletion, Young *et al*., (2019).

Table 1. Glaciers sources in Pakistan

Glacier	Area (Sq.Km)	Length in Km	Region
Hisper	620	53	Karakoram (Nagar)
Batura	290	58	Karakoram (Hunza)
Baltoro	755	62	Karakoram (K-2)
Biafo	625	68	Karakoram (Shingar)
Siachin	1180	75	Karakoram (Baltistan)

Sources: WWF Report Pak. 2012.

Table 2. Average Water Resources in Pakistan (Annual) in Billion cubic meters

	Ground-water	Surface-Water	Total
Kharan Desert	0.6	2.9	3.5
Makran Desert	0.7	6.2	6.9
Indus Basin	12.7	205.7	218.4
Total	14.0	214.8	228.8

Sources*:* FAO 2011; Young *et al*., 2019.

Water Scarcity Reasons

There are several reasons for water shortage but the main ones are

Lesser rainfall

It is the hydrological/water cycle that can determine and regulate different processes which helps in maintaining the water cycle of the ecosystem and all sorts of lives. This water-cycle is dependent on the evaporation of water from different sources. But greater contamination of water bodies like lakes, rivers, and oceans badly affects the cycle. Rain contributes only about 5-10% to irrigation of crops in Pakistan. On the other hand, a forest that helps in regulating rainfall in a country is cut down in Pakistan. According to UN report about 7000-9000 hectares of forest area are demolished per year in Pakistan. Moreover, in Pakistan instead of 25%, only 5% of the total land of the country may be called as forested. Continuous decrease in the forest area may result even in a much more disastrous condition (Salim et al., 2015). In June 2019 rainfall in the country on a regional basis was above normal in Gilgit Baltistan 292%, Balochistan+3%, and lower than normal in Azad Jammu and Kashmir -2%, Khyber Pakhtunkhwa -12%, Punjab -14% and Sindh -79%, Pakistan Metrological Department (2019).

Silted water reservoirs

Shortage of water which in turn results in severe load shedding enraged the population of Pakistan and they faced loss of trillions of rupees per month. In response to this situation, nobody has considered the root cause of the problem which is the silting up of water reservoirs. The silting up of the reservoir demolishes the life-period of a reservoir which is also a source of irrigation for agricultural purposes. This issue is as dangerous as the shortage of water and power itself. The silting up may be most prominently seen in cases of Tarbela as well as Mangla (the bigger water reservoirs in Pakistan). The silting up of these two reservoirs resulted in the deterioration of about 6.6-million-acre feet in about 36 years. This situation is more drastic. The higher silting rate has deteriorated the water storage capacity as documented and recommended under the Indus Water-Treaty (IWT). The reservoir capacities that have been lost due to silting-up phenomena need urgent reinstatement which is also part of the IWT. When reservoirs are silted up the storage capacity is decreased and in turn, crops are destroyed, for which the dams are built, and storing of water is suggested. In a similar manner control of floods is also equally mandatory like controlling silt to stop losses in terms of property as

well as every sort of life and to make it available and be stored in reservoirs for agricultural needs, Salim et al., (2015). In addition to Tarbela and Mangle reservoirs total losses as a result of silting up of reservoirs areapproximately13.20-million-acre feet in Pakistan.

Extended droughts

As surface water depends upon rainfall, so shortage of rainfall in turn will cause a shortage of surface which eventually will lead to drought conditions in the area. This will in turn increase the dependency of irrigation upon ground-water; hence the level of water-table will be disturbed and will go deeper which will further endanger the nation's lives. In Pakistan, the occurrence of drought is a rising problem. Qureshi and Smakhtin (2004), evaluate the degree and efficiencies of native approaches for justifying the end products of drought. The occurrence of drought in Pakistan is gradually more ordinary with considerable costs on natural resources, the environment, livestock production, and food security. Through the last five years, the country has undergone the most horrible drought of its times past. Because of erratic and low rainfalls, the provinces of Sindh and Balochistan are highly susceptible to droughts. In the past because of drought approximately 2.5 million domestic animals died and the countrywide growth rate pushed from an average of 6% to below 3%.

Insufficient water storages

Among the major causes of water shortage is insufficient storage capacity. According to recent estimates in Pakistan per-capita capacity of water storage is extremely low compared to other countries. The per capita storage of Iran is 492 m^3, Turkey 1402 m^3, Egypt 2362 m^3, China 2200 m^3, Australia and USA are over 5000 m^3, while in Pakistan it is only 159 m^3. The storage capacity of India is 320, South Africa's Orange River 500, Murray-Darling Rivers and Colorado 900, Aswan High (Nile River) 1000, and Pakistan has a storage capacity of 30 days (Qureshi, 2011). Because of insufficient storage facilities, Pakistan spoiled unintentionally about a much greater amount of water (89 MAF) in the years 2010, and 2012 as well as 2014 floods, in addition to the overwhelming burden/effects on livestock, people, and infrastructure (Ashraf, 2016). But extra is desirable in terms of execution. Since the Tarbela and Mangla dams were commissioned in the 1970's and 1960's respectively, Pakistan has not started any largest dams. As a result, water storage capability has frequently moved away to less than thirty days against the smallest requirement of 120 days, UNDP (2016).

Massive population of the country

The greater the number of individuals, the more will be the use of water for life sustenance. In this way, there will be more demand for water which will further place pressure on effective and meaningful use of water (Table 3). Pakistan is among the most populous countries in the world and comes 6th on the scale. The population of Pakistan is increasing at a very rapid rate (1.52%) recorded in 2014, Salim et al., (2015). Huge populations (in millions) that come across water-scarce conditions for some part of the year reside in 130 in USA (western counties of California and southern areas of Florida and Texas) 130 in Bangladesh, and 120 in Pakistan. In Pakistan out of these 85% reside in Indus basin, 110 in Nigeria, and 90 million in Mexico, Mekonnen and Hoekstra (2016).

Indus-Water-Treaty

Pakistan came into being in 1947. The same year a dispute regarding the distribution of water between these two newly came to existence countries (Pakistan and India) took place. So, with the help of World Bank a Treaty named Indus-Water-Treaty was signed in the year 1960. According to this Treaty division of rivers as well as the relevant canals was made between Pakistan and India. Pakistan got the rights of three western rivers. Names of these rivers are Jehlum, Indus, and Chenab. India was given the right to use three eastern-rivers. The names of those rivers are Sutluj, Beas and Ravi. It was guaranteed according to this treaty that for the next ten years there will continuously supply water uninterruptedly. So, Pakistan needed to build huge reservoir dams, which were supposed to be financed by the World Bank and money given as compensation by India. In this connection, Mangla, Warsak, and Tarbela were constructed by Pakistan. Furthermore, remodeling and redesigning of the current canals were also conducted. Besides this, a gated siphon and five numbers of barrages were also built according to this Treaty. As per this Treaty total water sold to Pakistan was about 24-million-acre feet whereas, it irrigated only an area of 8MA of land. The total cost of the treaty was 62 million (pounds). It was a big loss to the newly established country and it turned the country water-scarcer, Story of Pakistan (2003).

Water-seepage

It is the process involving water moving bottom-wise as well as sidewise from the canals/rivers and the peripheries of that canal/rivers and eventually towards the soil. This is called water-seepage. In Pakistan, these losses are much higher and are about 8-10 cusecs/million square foot cross-section of the irrigated land and reach up to 35-40% of diverted water into the canal. Annually, 18.3 MAF of irrigation water is lost due to seepage of water from uncemented canals and the passages through which water is passed. It is estimated that if these seepage losses are controlled then it may be sufficient for irrigation of about 3 million acres per annum (Salim *et al.*, 2015). The irrigation system of Pakistan is among the largest on the globe, comprising approximately 17 MHA of area. Even contrary to this the most prominent incompetent systems in terms of irrigation are also

prevailing in Pakistan where about 60% of water is wasted during transportation to the canals and subsequent use in the fields of the areas. The highest irrigation water wastage takes place at the water route level (30%) because of seepage and leakage, while at the field level (29%) because of unscientific irrigation procedures, Qureshi and Ashraf (2019).

Table 3. Availability of Water (Per Capita)

Year	1951	1961	1971	1981	1991	2001	2011	2025
Population (million)	34	46	65	84	115	148	170	267
Water Availability (m^3)	5300	3950	2700	2100	1600	1200	1050	660

Source: UNDP Report (2005).

Low Water Prices

In Pakistan, the water price is very low and this is the main cause of overuse and wastage of water. Canal-water for irrigation is provided to the cultivators roughly without any cost which is 85 rupees per acre in Kharif crop season and 50 rupees for Rabi-crops on account of "Abiana". This fee is equivalent to the price of about 4 kg wheat-granule. The Abiana rates are extremely low as compared to the cost for diesel-run water tube wells (Rs. 6000/acre) in the case of wheat crops. Furthermore, the Abiana rates unchanged/not amended in the last few decades. The amount of expenditures for Abiana being collected from the farmers is increased at a rapid rate than the total amount of Abiana. These expenditures are further increased due to the repair of the irrigation system which is badly overburdening the situation. Consequently, a balanced scheme of water costing procedures should be launched, Qureshi and Ashraf (2019).

Domestic and Industrial Sector Water Pollution

In the present scenario it is observed that as maximum water utilization (more than 93%) takes place in agriculture and a minimum water utilization (about 5%) is occurred in industrial and domestic sectors, as a result, we should be more worried regarding the farming area to get better its water management. No doubt the household and industrial sectors' water utilities are low in comparison to the farming sector; however, it has a lot of deductions for the ecosystem and society. Almost 100% of industrial and 90% of domestic water originated from ground-water, the excessive utilization of water consumption resulted in lowering the permanent water table because of urbanization. This experience is happening in approximately every urban area and will result in greater effects on dwellers' well-being and health. Moreover, merely a five percent portion of the water is utilized in household activities, Jan and Batool (2016), and the remaining 95 percent is drained back as wastewater and this wastewater ultimately finds its way into the surface-water. Annually more than 4 MAF waste water is produced from 16 major cities. Contrary to this there is greater potential for recycling (about 10 MAF)of wastewater, Ashraf (2016). Moreover, this wastewater may trickle down to the low-lying aquifer systems.

Water Scarcity Impact

Energy Crises

The shocking jump down in water storage level has also caused a severe deficit in hydal-power. These are drastic conditions if persist for a longer time. The power failure disaster will also be dominating progressively with time and it will become even more severe with downward movement of water level in the existing dams.

Agricultural sector

Decreased crops

Water scarcity has a severe effect on the farming sector of Pakistan and this sector is the backbone of our economy. Agricultural fields in Sindh as well as Punjab depend mostly on canal-irrigation due to a few land's underground water being salty. The current water shortages, if continuous, would decrease the yield of sugarcane, rice, wheat, etc. Momentarily crises of water in Pakistan have increased profound worry. The scarcity is alarming enough to produce starvation-like situations in the whole of Pakistan. Low water indicates decreased crops or poor agricultural yield therefore it will add to build us reliant on other countries to meet our crop's necessity.

Economy

The condition of water scarcity is a combination of enormous issues that affects every sort of economy and goes beyond the subject of physical-drought. Pakistan is also among the nations that are impacted by water-scarce conditions. Different issues that resulted due to water-scarce conditions include, a reduction in crops, cultivable land areas, forest goods and non-timber products, and water table. In other words, it may result in enhanced rates of mortality in livestock and humans and damage wildlife as well as fish life. The impacts and damages arising as a result of water-scarce conditions are so penetrating and long-lasting that it becomes difficult to calculate the losses in terms of economy and finance.

Social Factors

The social issues about water scarcity are also innumerable in this region. These problems include health issues, public-safety, and mutual conflicts raised due to the uneven distribution of water and its royalty among the provinces of Pakistan. These problems also deteriorate the life standards of the citizens. Moreover, the rural population is strongly dependent on agriculture. So, if agriculture in rural areas is affected, it will endanger the survival of the

rural individuals and will result in joblessness. So, they will become compelled to migrate to the urban areas for life sustenance and seeking other sources of income which is already an undeniable issue in Pakistan.

Export of Orchards will be reduced

As Pakistan is an agricultural country there are certain plants, trees, and herbal resources which are exported abroad and generate large revenue. Due to the onset of water-scarce conditions, there will be very little chance for these earlier-mentioned plants and orchards to grow and be able to be exported. Therefore, there will be nothing to export to foreign countries.

Promotion of the livestock industry

Due to water shortage, there will be no chances for conjuring and leavening of livestock as life without water is not possible. Mutual conflict among the nation: If there are abundant water resources in the country then there will be nothing regarding water distribution to fight for. However, in the case of water-scarce conditions, it will be difficult for the government to distribute water evenly due to certain geographical and natural factors. So, in that case, the province receiving little water will certainly fight with the province receiving abundant water. This will challenge the integrity of the nation of Pakistan. If the issues remain for a longer time, they will have even deeper and greater effects.

Health concerns

In case of water-scarce conditions, the public will be helpless and will start using water from unhygienic sources (canals, streams, and other untreated industrial effluents). The use of this unhygienic water supply will certainly enhance the health problems in the country. Therefore, these streams become highly contaminated and become a sort of culture media for the easy growth of microorganisms which result in evoking water-borne health issues like typhoid, dysentery, and cholera in humans that are silent killers.

Thirst and hunger

As is famous saying that "There will be no life if there is no water". Water is vital for the life of crops and for keeping animals for household requirements. It has been estimated that out of a total of 70 % global use of water for agriculture, 10% for domestic and 20% for industrial uses, World Bank (2006). So, whenever, water level is affected then their impacts on crop production and as well as farming will certainly be undeniable. This will eventually result in lower crop yields and enhanced mortality rate of animals especially in the water-scarce arid areas as well as absolute water-scarce regions. These conditions, in turn, will nourish poverty, thirst, hunger, and malnutrition.

Poverty

The provision of clean drinking water for quality living is the basic right of every individual for maintaining health conditions and for economic strength. All living places like restaurants, hotels, hospitals, basic health units, and business centers should be neat and clean for smooth, effective, and hygienic operations. If the restaurants, holiday's resorts, shopping malls, and hospitals are not maintained clean then the situation will worsen and will result in economic losses and productive manpower shortages on and off. In this way, long-lasting effects cannot be manageable. On the other if these were neat and clean it would help in increasing the prosperity, healthiness and more visitors both local and foreigners would be attracted towards the country and these would contribute to the economic stability of the country. Major industrial, manufacturing units, mining sectors, business chambers, and commercial sectors require bulk quantities of water to prosper. With a small amount of clean and hygienic water poverty and substandard living obligations a sound mind will be in a sound body.

Impact on Environment

Ecosystem and the environment are interdependent and both have a dependency on each other in several ecological and environmental cycles. Change in environmental phenomena causes a change in plant growth, animal behavior and habitat, wildlife, water, and air quality, flooding conditions resulting in landscape disturbance, the distinction of biodiversity, and erosion of soil due to the onset of prevailing water-scarce conditions. Deforestation and little growth of plants and herbs due to drought conditions result in an increase of bare land with no roots and plants, which helps in resisting landslides and prevention of flooding situations.

Water-scarcity and its remedial measures

The following views/comments/inputs/further suggestions are submitted for further necessary actions are;

Pakistan encountered threatening challenges to meet the demands of the nation regarding fresh and clean water which are increasing day by day and hence decreasing water resources in the same fashion due to several reasons.

The following are the remedial measures and way forward for an overall picture of water Scarcity in Pakistan.

(1) Build more water storage reservoirs. (2) Implement and develop efficient policies for water control. (3) Preparation and planning of budget for water management. (4) Devising management plans for control of seepage and runoff management (5) Appropriate utilization of water used for irrigation like Drip, Basin, and Sprinkler irrigation. (6) Recycling wastewater for irrigation. (7) Capturing rainwater to replace other sources of water with this

captured rainwater. (8) A strategy regarding water control via the processes of leaching, percolation, and seepage by cementing the walls and the peripheries of canals and distribution channels holding water. (9)Encouraging moderate use of underground and surface water for irrigation as well as checking on pumping of underground water resources. (10) A strategy should be devised to cover more areas with little water wastage and provision of facilities for water treatment. (11) There should be water quality monitoring and quality surveillance systems regarding water resources. (12) Treatment plant should be declared as an integral part of all supply schemes concerning drinking water. (13) There should be a plan for the treatment of water at household and community levels and low-cost treatment technologies should be promoted. (14) There should be a detailed water-capturing strategy regarding rainwater in urban as well as rural areas. (15) In Both arid and semi-arid regions there should be a plan for artificial recharge of groundwater resources. (16) To manage water consumption in a more economical way consumption meters should be introduced to avoid wastage of water both for municipal and industrial purposes. (17) There should be an Act regarding the conservation of water resources and standards should be enacted to promote water conservation strategies. (18) There should be a plan regarding the management of watersheds in an integrated manner. (19) Freshwater flow in the marine environment should be monitored systematically. (20) There should be yearly programs for cleaning and renovation/upgradation of the water-quality in multiple phases. (21) There are many organizations relevant to water such as researchers, engineers, social activists, generalists, civil servants, and scientists but still they need special skills in local politics, cultures, economics, engineering, community, population, ecology, and climate. (22) There should legal framework and policy to endorse hygienic and clean water in Pakistan which may help in its practical implementation. (23) There should be training workshops organized for Government personnel to build up flexibility in their behavior and technical skills so that to work with private donor organizations, local government, and businessmen. (24) Higher prices for water to decrease waste of water, improved water organization, better technologies to increase efficiency, investment by the government, communities, and private sector in primary water infrastructure, and collaboration among societies sharing water resources.

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Declaration

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Authors contribution

JA**:** Conceptualization of the study, experimental design, and manuscript writing. JA**:** Data acquisition, statistical analysis, and result interpretation. HS**:** Supervision of laboratory procedures and validation of experimental protocols. JA: Literature may be fictitious or non-fictitious, a key revision of the manuscript, and a final blessing of the satisfied. IU**:** Technical support, resource management, and administrative oversight. The author have read and approved the final manuscript.

Conflict of Interest

The authors state that there is no conflict of interests with regard to this study. There is no conflict of interest in any financial or personal manner concerning the development of this project, the gathering of data, the interpretation of the data, or the writing and publishing of this paper.

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All authenticated data have been included in the manuscript.

Ethics approval and consent to participate

These aspects are not applicable in this paper.

Consent for publication

Not applicable