Pakistan Water Issues and the Way Forward

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Abstract

Pakistan has one of the largest irrigation systems and the fourth-largest groundwater aquifer in the world. However, these systems, both surface and groundwater, are subject to several issues, such as: (i) inadequate storage leading to an increasing gap between water supply and demand, (ii) reduction in the storage capacity caused by siltation due mainly to lack of watershed management activities, (iii) neglect of rain-fed areas, (iv) low irrigation system efficiency due to poor maintenance of the irrigation channels and conventional irrigation methods, and (v) groundwater depletion due to indiscriminate installation and operation of tube wells. The above issues can be overcome by (i) increasing the resource base, i.e., construction of small, medium and large dams where possible, rainwater harvesting and recharging the groundwater aquifer, (ii) managing the available water resources through improving conveyance efficiency (watercourse lining/improvement), and application efficiency (using high-efficiency irrigation systems), changing the existing cropping pattern and introducing the low delta crops/plants, controlling the indiscriminate installation of tube wells, and (iii) mass public awareness campaign for water development, conservation and management.

Keywords: Water resources development, water resources management, water productivity.

1. Introduction

Nature has blessed Pakistan with many natural resources including water, which helped to develop one of the world's largest irrigation systems and the fourth-largest groundwater aquifer in the world. The vast and integrated irrigation system irrigates about 17 Mha of land and is considered crucial to ensuring food security for over 220 million people. The country's food security is mainly linked to its water security.

Lying in the arid zone, the country is dependent on irrigation water for agricultural purposes. However, due to the rising population and continued economic

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development activities in the agricultural and industrial sectors, the pressure on both surface and groundwater resources has increased tremendously.

This has resulted in converting the once water-surplus country into a water-scare country. Climate change phenomena have further aggravated the situation. The country is witnessing both floods and droughts with the wet seasons and wet years becoming more wet and the dry seasons and dry years becoming drier (Ashraf, 2023). This is evident from the increased frequency of both flood and drought events. Recent rainfall patterns are indicative of higher intensity and duration in many parts of Pakistan. On the other hand, droughts have also become longer in duration and intensity. Under these circumstances, the storage reservoirs and their operation on an optimal basis are becoming more critical and challenging.

Extreme heat waves during March 2022 and subsequent heavy flooding throughout the country are recent examples. All these factors have threatened the food security of the country. According to Boyd (2002), Pakistan will be facing a food shortfall of about 70 million tons by 2025.

2. Major water-sector challenges

Pakistan's water challenges are multi-sectoral and multi-dimensional. One of the greatest challenges is the growing water scarcity scenario caused by the growing population. It has been reported that with the same rate of population rise, the available water resources cannot meet water requirements to feed the country. It is estimated that the country will be touching the absolute water scarcity line of annual per capita water availability below 500 m^3 by 2025 (Ashraf, 2016; Ashraf, 2022; Qureshi and Ashraf, 2019; Ashraf, 2023).

The other big challenge is inadequate storage capacity. The storage capacity of reservoirs in Pakistan has been reduced from 16 MAF to 13 MAF due to sedimentation. This is less than 10% of available water and well below the world average of 40%. The lack of watershed management in the catchment areas, and unplanned urban expansions and infrastructure developments are resulting in sedimentation of the existing reservoirs - Tarbela and Mangla have lost almost 35% of their storage capacities (Iqbal et al., 2012).

Another great challenge is the mismanagement of water resources in all sectors and at all levels. The agriculture sector is the largest user of both surface and groundwater resources and is responsible for maximum losses. For instance, more than 60% of the water is lost during conveyance from the canal and its application in the field. In quantitative terms, this loss is of the order of 60 MAF annually. If

only 10% of these losses are reduced, the savings would be of the order of 6 MAF annually.

Similar is the case with the domestic and industrial sectors. Currently, water tariffs in both the agriculture and industrial sectors are minimal (almost free), which acts as a disincentive to promote water savings. Though water use in the domestic and industrial sectors is small, however, it has a great impact on the ecosystem (Qureshi and Ashraf, 2019). The greater the water use in these sectors; the greater will be the wastewater generated and the greater will be the pressure on the groundwater. Due to these reasons, groundwater is depleting almost in all sectors. With the increase in depth, groundwater quality deteriorates and pumping becomes uneconomical. Changes in water quantity and quality will impact food production.

Rainfed areas constitute about 40% (12 Mha) of the culturable area of the country. This is the area where the poorest of the poor reside and their livelihoods depend on rainwater. This area has not received due attention, as major investments in the water sector have been in the development of irrigated infrastructure and its operation and maintenance. There is little doubt that, if properly managed, the rainfed area has huge potential to ensure better food security for future generations.

Poor governance across all sectors of the economy is another important challenge that needs attention. In the water sector, low water pricing, lack of crop zoning, and lack of groundwater regulatory framework constitute major governance issues that result in very low water productivity. While the low water tariffs act as a disincentive to ration the use of water for irrigation, lack of crop zoning results in high-delta crops like rice and sugarcane being grown in water-scarce areas not suitable for such crops thus largely impacting the water supply and demand of the area. The lack of an effective groundwater regulatory framework has resulted in a mushroom growth of tube wells ultimately depleting the aquifers.

2.1. Key interventions by PCRWR

The above scenarios have given birth to questions like: are there sufficient knowledge and best management practices available to cope with the situation and are the current water management practices robust enough to cope with climate change? Sufficient efforts have already been made to find answers to these questions in the form of demonstration and pilot projects. The problem is how these can be up-scaled.

The Pakistan Council of Research in Water Resources (PCRWR), in collaboration with other provincial, national and international organizations, has developed a

strong knowledge base on existing water resources in the country. In the process, several climate-smart interventions were developed to address these issues.

2.2. The Myth of Rice Cultivation in Standing Water.

Rice is considered to be one of the highest water-requiring crops. For centuries rice has been grown in standing water, which is the main reason for its high production in the delta. However, PCRWR, through a series of experiments, has proved that the standing water requirement for rice cultivation is nothing more than a myth, as the crop does not need standing water. Rather, it can be grown using any method including bed and furrow, ridges and even sprinklers. The important point is to provide enough water as per its requirements. The rice water requirement in Central Punjab is 480 mm, whereas in the Lower Indus, it varies from 1200 to 1400 mm. However, farmers apply more than 5000 mm of water resulting in one of the lowest water productivity in the world (Rao et al., 2016; Soomro et al., 2018). Keeping water standing is not only a waste of water but also results in the wastage of precious nutrients, waterlogging and salinity, pollution of soil, and the environment. The provincial agriculture extension departments need to play their due role to discourage farmers from the practice of growing rice in standing water.

2.3. Water Scheduling.

One of the major components of water application in the field is the knowledge about irrigation scheduling (when to apply and how much to apply water?). Due to the lack of this knowledge, farmers keep on applying water even when crops do not need water. This results in wastage of water.

Irrigation scheduling is based either on the availability of soil moisture data or on climate data using empirical equations. Both methods are difficult for farmers to adopt. PCRWR launched a satellite-based Irrigation Advisory Service (IAS) in 2016 to improve water applications at the farms. This system estimates real-time and future water requirements of different crops using earth observations from NASA satellites and weather forecasts from the Global Numerical Weather Prediction model. Crop coefficients determined by PCRWR through drainage-type lysimeters are used to calculate actual water requirements. The information thus produced is broadcast weekly in Urdu language using mobile text messages to 20,000 registered farmers in 43 districts across Pakistan.

2.4. Groundwater management.

Groundwater investigation and mapping are very important for designing tube wells and developing operational strategies. PCRWR has mapped the entire Indus basin (Fig. 1) covering an area of about 24 Mha (Iqbal et al., 2020).

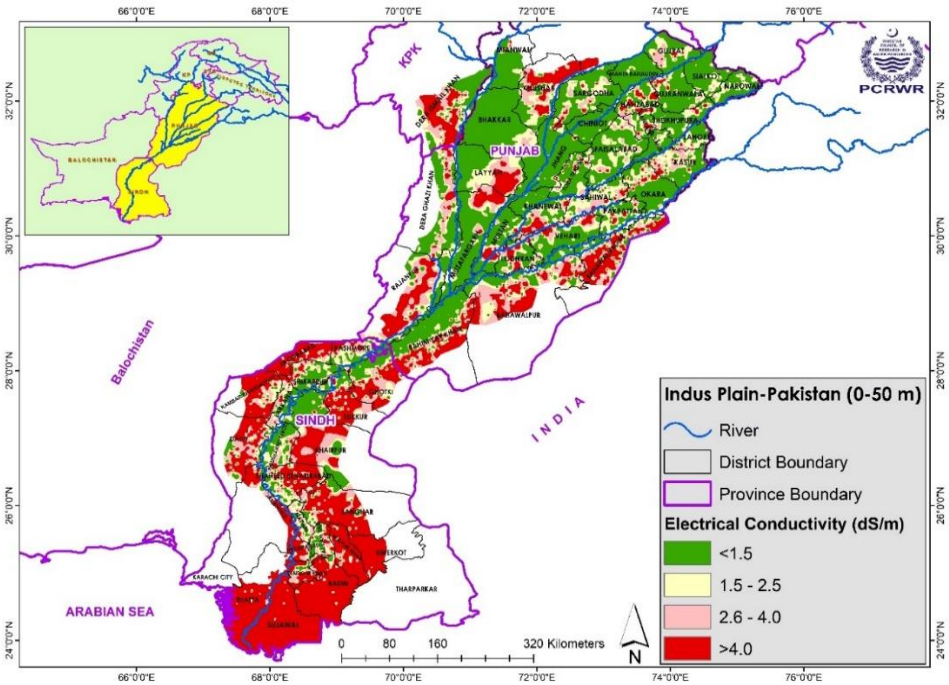

Figure 1. Groundwater quality of the Indus Basin at 50 m depth (Source: Iqbal et al., 2020).

Taking cognizance of water scarcity in desert areas, PCRWR has also initiated several rainwater harvesting and groundwater projects in the country. One such project is the construction of over 100 rainwater-harvesting ponds in the Cholistan desert. Following it, the Cholistan Development Authority also constructed an almost similar number of ponds. These ponds act as a buffer against drought and provide resilience against climate change and variability. Similar kinds of ponds have been constructed in the D.I. Khan, Thar and Chagi-Kharan deserts (Ashraf, 2021).

PCRWR has introduced simple, smart and cost-effective recharging techniques in Baluchistan such as inverted wells/recharge wells (Fig. 2). The recharge wells collect rainwater and allow the water to flow under gravity to the groundwater through a well-developed filtration system that removes the debris and sediments

from runoff to allow only silt-free water into the bore to avoid the choking of wells (Fig. 2). The pre-filtration is provided by making a pit and filling it with different natural filtering materials in layers such as gravel, stone crush and sand. More than 80% of the water diverted towards the well recharges the aquifer. The council has installed these wells at several sites throughout the country.

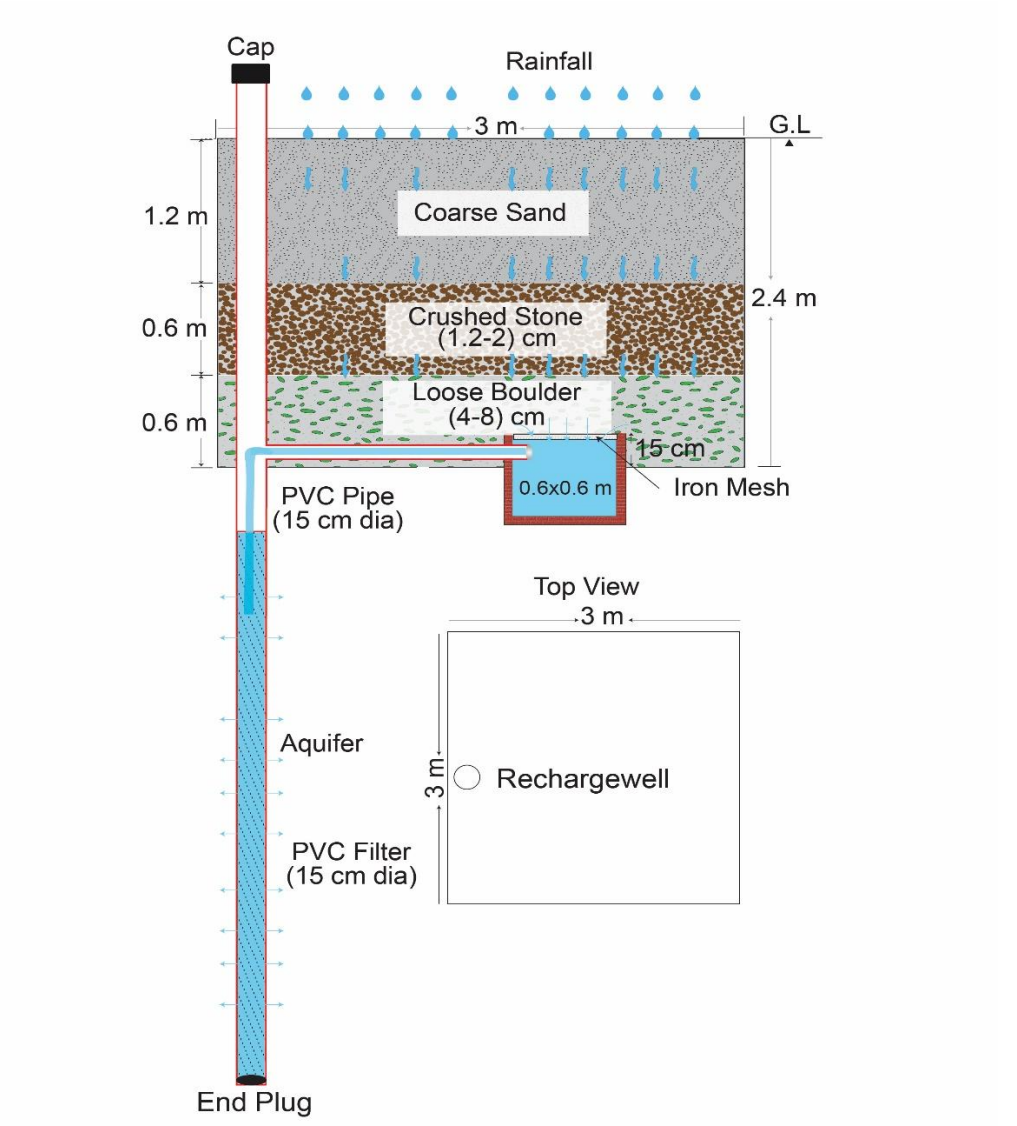

Figure 2. Schematic diagram of a recharge well (Source: Ashraf, 2021).

The techniques developed by PCRWR are now being adopted by various development agencies, such as the Capital Development Authority (CDA)

Islamabad and Rawalpindi Chamber of Commerce and Industry. However, there is a need to upscale these technologies on a larger scale to cope with the issues of climate change and variability. Groundwater recharge should be an integral component of any water development scheme. Rainwater collected from rooftops, public parks and playgrounds should be diverted to the aquifer through recharge wells. The recharged water would help sustain the existing tube wells which otherwise have to be deepened or re-drilled after every few years (Ashraf, 2021).

3. The way forward

In the wake of the current water situation, a single solution may not work; instead, applying an integrated approach would be suitable. The following actions are proposed.

1. The country needs to focus on increasing its storage capacity. Pakistan relies on a single Indus River system where about 84% of water is received during 3 to 4 monsoonal months. Hence, storage is essential to regulate the water over the year, control flooding and provide hydropower. We need to divert more investments towards increasing storage capacity by constructing small, medium and large dams, wherever possible. This would not only help shorten the gap between water demand and supply, but would also help control floods which have become a regular feature (floods of 2010, 2012, 2014, 2022), besides providing hydropower – the cheapest source of energy.

2. The stored water in dams or in underground aquifers is very costly and precious and, therefore, needs to be used efficiently and judiciously. For this purpose, efficient water management techniques and equipment need to be introduced with proper legislation. While attention is needed on introducing a rational water pricing system, high delta crops such as rice and sugarcane must be restricted to those areas where sufficient freshwater is available.

3. Pakistan needs to undertake an effective and well-organized mass awareness campaign to educate the farmers, general public and industries on the importance and value of water in our lives and techniques to save water.

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