

ISAS Working Paper

No. 274 – 16 October 2017

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Water Management Practices in Pakistan

Water is one of Pakistan's biggest challenges. The current discourse focuses largely on inter-state water sharing and its impact on water availability in Pakistan. This paper argues that Pakistan's acute shortage of water is the outcome of distorted water management practices. An in-depth look at supply and demand practices reveals deteriorating infrastructure, below-cost pricing of water, inefficiency in usage and an absence of alternative sources of supply.

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Introduction

Pakistan is among the 36 most water-stressed countries in the world. Water stress occurs when there is less water available than needed. It is typically measured at annual per capita renewable freshwater availability of less than 1,700 cubic metres. Water stress turns into scarcity when per capita availability falls below 1,000 cubic metres, and absolute scarcity at levels under 500 cubic metres.

According to the World Bank, Pakistan became a water-stressed country in the year 2000 (Briscoe & Qamar, 2005). The International Monetary Fund (IMF) estimates (Figure 1) per capita availability is only 1,017 cubic metres (IMF, 2015). Pakistan government's own

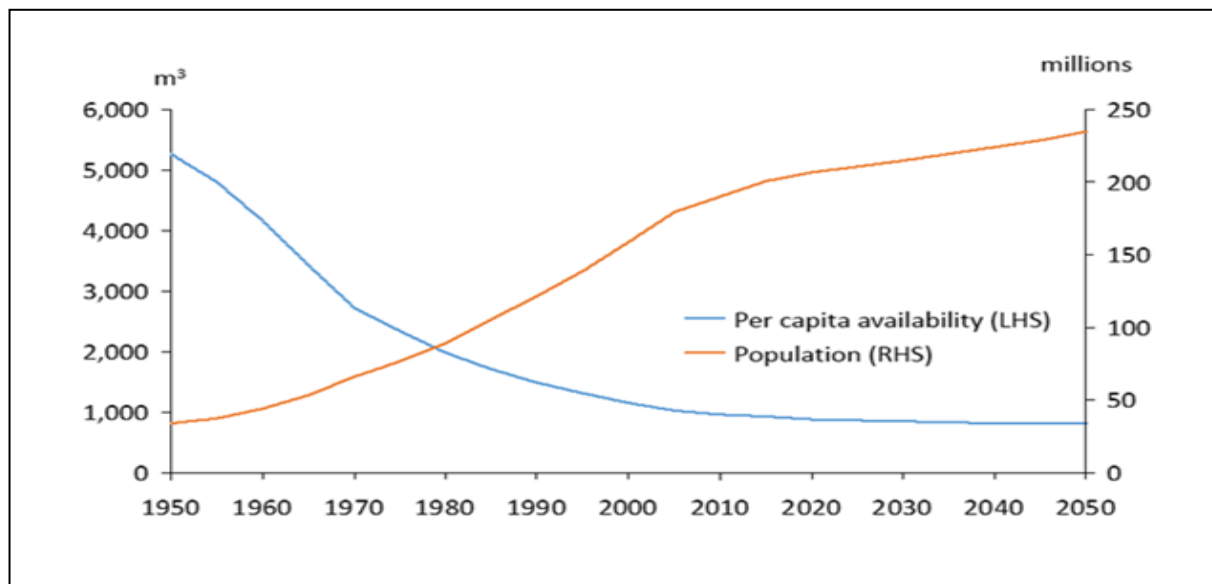
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organisation, Pakistan Council of Research in Water Resources, states that the country touched the water stress line (1,700 cubic metres) in 1990 and crossed the water scarcity line (1,000 cubic metres) in 2005.²

Water is an essential human need. Lack of it hampers a nation’s socio-economic development, health and productivity. For Pakistan, water availability has become a fundamental challenge due to:

- 1) **Burgeoning population.** Pakistan is the sixth most populous country in the world, home to an estimated 208 million people.³ By 2030, its population is expected to grow to 244 million, and, by 2050, it may exceed 300 million.⁴ A growing population will increase the demand for water. For instance, demand for water in 2025 is estimated to reach approximately 274 million acre-feet (MAF) per year, whereas supply is expected to remain at 191 MAF. Thus, the demand and supply gap is expected to grow to 83 MAF (IMF, 2015).

Figure 1: Water Availability in Pakistan



Source: IMF. (2015) (pp. 12-15). *Pakistan: Water Availability (m³/person)* [Figure 7]. Retrieved from <https://www.imf.org/external/pubs/ft/sdn/2015/sdn1511tn.pdf>

² The Express Tribune. (2016). Pakistan may run dry by 2025: study. Retrieved from <https://tribune.com.pk/story/1112704/pakistan-may-run-dry-2025-study/>

³ According to the latest census in 2017. For details see: <http://www.pbscensus.gov.pk>.

⁴ See ‘World Population Prospects, 2015 Revision’ at https://esa.un.org/unpd/wpp/Publications/Files/Key_Findings_WPP_2015.pdf.

2) Agriculture-dependent economy. Agriculture is a key activity in the country and accounts for 21 per cent of the gross domestic product (GDP) while directly and indirectly employing 45 per cent of the total labour force. It also supports 90 per cent of the food requirements of the country.⁵ Given the arid to semi-arid climate of the country, irrigated agriculture is practised, utilising water primarily from rivers but also rainfall and groundwater. Therefore, water shortages may adversely impact Pakistan's agriculture sector and consequently its economy.

In addition to pressures from a rising population, urbanisation and food security needs, Pakistan is challenged by the effects of climate change, causing a high degree of unpredictability in water availability. The current discourse on water, however, focuses primarily on water sharing between provinces and neighbouring India, with which Pakistan shares the Indus River Basin. While inter-state water issues are important, a focus on them overshadows the internal inefficiencies and failures of institutions combined with the distorted water management practices that contribute to this issue.

This paper looks at water resource management in Pakistan. It begins with a brief discussion of the institutional and policy framework for water in the country and follows that up with an in-depth exploration of factors within supply and demand that contribute to the country's water woes.

Institutional and Policy Framework

This section examines the federal and provincial institutions and policies for water management in the country.

Institutions

Federal Level: In Pakistan, water governance is decentralised, with institutions at both the national and provincial levels. Those at the federal (national) level are responsible for resource allocation. They are chiefly concerned with trans-boundary and inter-provincial

⁵ Ministry of Finance, Pakistan. (2016) (p. 13). Retrieved from http://www.finance.gov.pk/survey/chapters_16/02_Agriculture.pdf.

issues regarding water allocation along with water infrastructure and hydel power development.

All federal-level organisations work under the Ministry of Water and Power. The ministry develops water resources and allocates them across the country. It also manages key organisations, including the Water and Power Development Authority (WAPDA), Indus River System Authority (IRSA) and Federal Flood Commission.

The institutional framework at the national level is complex, characterised by large bureaucracies, often disconnected with one another. This leads to poor coordination, an overlap of responsibilities and consequently lower accountability.

In the Ministry of Water and Power, water tends to feature low on priority. For instance, it has no policy department, although it is supposed to set the country's strategy in water resource development and management. The staffing patterns also signify the lack of priority on water. It has six joint secretaries and only one deals with the water sector while the others are assigned the power sector (Hasan, 2014).

The priorities and capacity of the ministry translate down to the national-level organisations, which are in a state of disarray. For instance, WAPDA was created in 1958 as a semi-autonomous body to coordinate the development of schemes in the water and power sectors. It did commendable work during the 1970s and 1980s (Indus Basin Works and thermal power stations), and had a reservoir of skilled staff and technical knowledge. It was also able to complete multiple projects including construction of barrages, link canals and power stations. However, over time it became too large and inefficient. In 2007 it was split into two entities – WAPDA responsible for water and hydropower development and Pakistan Electric Power Company responsible for thermal power generation, transmission, distribution and billing. The reduced scope of responsibilities has also resulted in a decline in planning and design capacity and a dearth of trained staff, including engineers. At present, WAPDA outsources projects and feasibility studies to external contractors and international organisations such as the World Bank (Hasan, 2014).

The Indus River System Authority (IRSA) is another organisation that has failed to fulfil its mandate. Till 1991, there was no institution or body to mitigate disputes between provinces,

even as irrigation supplies, hydropower generation and water supply to domestic consumers were affected. After the Water Apportionment Accord (WAA) was signed in 1991 and the provinces agreed on a water-sharing formula, IRSA was established to implement the accord. It is a five-member body consisting of one representative from each province and one from the federal government. Provincial disputes over water-sharing are common and IRSA cannot ensure implementation or enforce penalties. For instance, in 2004, the Punjab government rejected IRSA's water allocation. Subsequently, the IRSA chairman accused the Punjab government of drawing more water than it had been allowed. Punjab, however, felt that it was 'discriminated against' so Sindh could get a higher share of the water. In the end, the dispute remained unresolved (Khan, 2009). The IRSA also faces a shortage of resources. It has not been able to invest in an advanced telemetry system and it cannot measure actual canal flows and water course diversions. The uncertainty arising from a lack of in-house measurement systems causes severe difficulties in allocating water, especially during low flow periods (Yu, et al., 2013).

The decline in these national organisations is symptomatic of the crumbling institutional framework for water in the country.

Provincial Level: Decentralised water management has meant that provincial governments (and institutions under them) are responsible for irrigation management, water supply to domestic and industrial consumers and sanitation services.

Provincial Irrigation and Drainage Authorities (PIDAs) handle irrigation and drainage at the provincial level. Their role and functions include construction, maintenance and rehabilitation of barrages, canals and small dams, distribution of canal water, flood control and protection, assessment of water rates and drainage schemes (Hasan, 2014). The delivery of water supply and sanitation services, on the other hand, is the responsibility of local government institutions, except in the case of metropolitan towns and City Districts, which are given to Water and Sanitation Agencies and City District Administration (Hasan, 2014).

As at the federal level, the multitude of organisations at the provincial level prevents coordination and efficient service delivery. Efforts to improve the system have been largely unsuccessful. For instance, in the 1990s, the government (with World Bank support) implemented the Provincial Irrigation Authority Act of 1997. Through this act, the old

provincial irrigation departments were replaced with a three-tier institutional setup comprising PIDAs (discussed above), Area Water Boards (AWBs) and Farmers Organisations (Bandaragoda, 2006). In theory, this was an appropriate step towards much needed reforms in the water sector. It would allow an efficient distribution of water, closer cooperation with farmers and the maintenance of infrastructure. However, the well-entrenched bureaucracy of the old system offered extreme resistance and slowed the implementation process (Bandaragoda, 2006). For instance, the AWBs were tasked with the responsibility of managing the operation and maintenance of the irrigation network (main and branch canals). However, in Punjab province, till today, only five of the 17 planned AWBs have been set up by the Punjab Irrigation and Drainage Authority.⁶

In sum, there have only been half-hearted attempts at reform in both federal and provincial institutions. Combined with rampant corruption, red tape and weak laws, the country's water management problems continue to remain unaddressed.

Policy

National Level: A country's national water policy lays down the strategy for the planning and development of water resources and their optimal utilisation. Such a strategy is needed for all stakeholders in the water sector to come together and work with a common understanding and vision for the resource.

The national water policy was formulated in 2003 and has since gone through multiple iterations without being formally approved and implemented.⁷ Thus, in essence, the country does not have an official water policy. In its draft form, it touches on various issues, including planning and development of water resources, institutional and legal frameworks, water rights and allocations and trans-boundary water sharing.

⁶ For details, see http://pida.punjab.gov.pk/area_water_boards.

⁷ The draft water policy addresses inter-provincial water allocation which is the source of conflict between provinces. As a result, the policy document has been amended by successive governments depending on political motivations and affiliations, but never formally approved.

A review of the draft policy shows that it is an ambitious document, recommending actions and interventions in the water sector. However, it has three main problems:

- 1) Lack of an overarching vision. Given climate change and its potential adverse impact on Pakistan, as well as high population growth, the document lacks an overall strategy vis-à-vis Pakistan's goals and aspirations for managing this scarce resource.
- 2) Absence of an implementation plan. The policy does not delineate the phases and time frames needed for implementation.
- 3) Gaps in knowledge and technical expertise. The capacity-building needs of federal and provincial institutions to implement the policy recommendations are not addressed.

These shortcomings, combined with the inherent problems in water institutions discussed above, ensure that, even if approved, the national water policy will produce marginal gains at best.

Provincial Level: The provincial water policies are similarly non-existent. Among the provinces, only Balochistan has a policy in place. It framed and approved the Integrated Water Resources Management Policy (IWRM) in 2006, with the Asian Development Bank's (ADB) technical assistance. Its initiation was a commendable first step to water management in the province, as it receives only 32 per cent of its surface water from the Indus River and its tributaries and relies primarily on flood (63 per cent) and groundwater (four per cent) for its needs. It also has limited facilities for managing flood water (Hasan, 2014). To tackle these issues, the policy focused on developing water resources, managing water demand for agriculture and other uses, and recovering costs of irrigation infrastructure. In spite of its strengths, the IWRM failed to make a mark because of weak implementation.

The case of Balochistan's water policy shows that implementation is one of the biggest challenges in Pakistan. The provincial and local government officials are not trained and lack the technical and managerial expertise to implement recommended programmes. The IWRM policy in Balochistan was developed in consultation with the ADB. Although it addressed the key concerns of the provincial government with regard to water management, the ADB and its technical expertise were unavailable at the level of implementation, so none of what it

envisioned ever happened on the ground. At the same time, large landowners and politicians influence the provincial government officials, especially lower-level irrigation officials. Therefore, any policies detrimental to the influential landowners and politicians are blocked. This undermines the official policy and the authority of senior officers, who are then forced to retreat. Officials themselves view policies such as the IWRM as external donor-funded priorities that detract them from other ‘important’ tasks. Thus, they are not taken seriously and completed half-heartedly.

An examination of these issues indicates that the national water policy and the provincial policies, as a first step, need to create overarching visions for water management. Additionally, they need to address capacity gaps at all levels, to ensure successful implementation.

Water Management

Water management includes supply-side and demand-side strategies. Supply-side management of water focuses on provision of water and expansion of sources, whereas demand-side management centres on conservation and water-use efficiency. This section of the paper explores both, and examines key factors within each contributing to Pakistan’s water challenges.

Supply-side

Rivers, rainfall and groundwater constitute Pakistan’s water supply. The Indus River and its tributaries which flow into Pakistan are the biggest sources of water supply. The river originates in the Tibetan Plateau and makes a 3,200-kilometre journey southwards into the Arabian Sea. It is largely fed by the snow and glaciers of the Karakoram, Himalayas and Hindu Kush ranges, and passes through Jammu and Kashmir, Himachal Pradesh and Gilgit-Baltistan. The river flow decreases in the winters, while flooding is common in the monsoon months from July-September. It is divided between countries, with 60 per cent of the drainage basin belonging to Pakistan, followed by 20 per cent, 15 per cent and five per cent in India, Tibet and Afghanistan respectively. Pakistan uses the river and its tributaries for agriculture, hydropower generation as well as domestic and industrial needs.

Under the Indus Waters Treaty,⁸ Pakistan can primarily draw water from the western rivers (Indus, Jhelum and Chenab), which provide approximately 144.9 MAF, along with an estimated 9.1 MAF from the eastern rivers (Sutlej, Ravi and Beas). In 1991, the WAA estimated water allotment at 114.35 MAF with the balance going downstream to the sea.⁹ Due to variations in temperatures and resulting glacial melt, the inflow of water varies from year to year.

Rainfall is scanty and unpredictable in Pakistan, averaging approximately 290.7 mm per year (1960-200). There is potential of 17 MAF of rain water to be harnessed through storage facilities of which 5 MAF is currently conserved through construction of delay action dams,¹⁰ reservoirs, flood retaining walls, and diversion structures. (Rajput, 2011).

Groundwater resources play a vital role in food requirements and agricultural production in Pakistan. Since the 1960s, groundwater has been used extensively by farmers as a supplement to the irrigation system. Annual groundwater extraction through tube wells is approximately 45 MAF structures (Rajput, 2011). It is fast approaching the overexploitation stage as water tables are rapidly declining, leading to poor water quality.

The declining availability of water can be attributed to weaknesses in water management. On the supply side, three key factors are contributing to the issue – insufficient storage infrastructure, defective supply networks and lack of alternative sources. These are discussed in detail below.

⁸ The Indus Waters Treaty is a water-sharing agreement between India and Pakistan, signed in 1960 and mediated by the World Bank.

⁹ According to the WAA, Punjab gets the major share at 55.94 MAF, followed by Sindh at 48.76 MAF. Any extra supplies would be apportioned equally between Punjab and Sindh at 37 per cent each. The remaining (154-114.35) 39.65 MAF is designated at ‘Outflow to Sea below Kotri’ but includes all other withdrawals and losses. See Water Accord 1991 here: <http://www.waterinfo.net.pk/sites/default/files/knowledge/The%20Water%20Accord%20-%201991.pdf>.

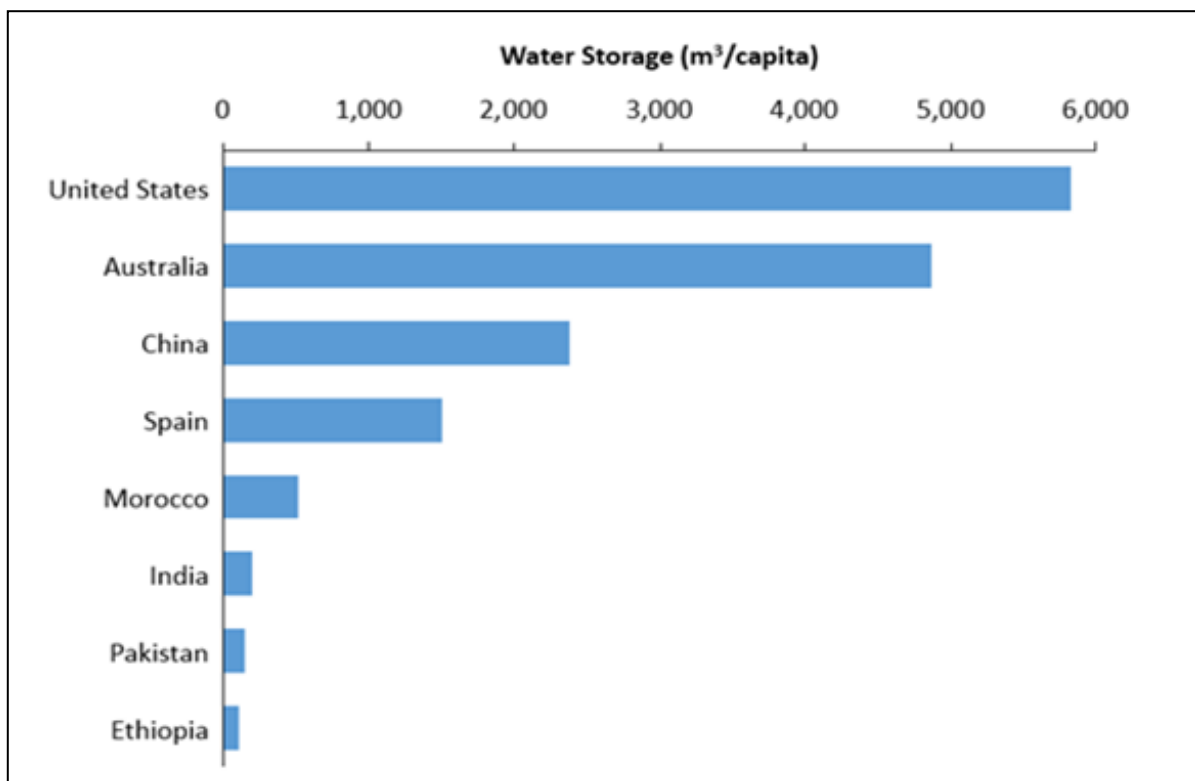
¹⁰ Delay action dam or check dams are built to control the accelerated flow of water. They help in ensuring availability of water later in the year and recharging of groundwater tables.

Insufficient Storage Infrastructure

The number of dams in Pakistan is woefully inadequate. Pakistan has 163 “large” dams, which are over the height of 15 metres. Small dams are between 10-15 metres in height but reliable figures do not exist on their exact numbers.¹¹

The number of dams in the country is important because it impacts storage capacity. Today, Pakistan’s water storage capacity is one of the lowest in the world. It can barely store water for 30 days, whereas the recommended supply is 1,000 days. Figure 2 shows that semi-arid countries across the world have invested in developing adequate water storage capacity. On a per capita basis, water storage is approximately 6,000 cubic metres in United States, 5,000 in Australia and 2,200 in China. Pakistan, on the other hand, stands at 150 cubic metres.

Figure 2: Per Capita Water Storage in Semi-Arid Countries



Source: *Briscoe and Qamar 2006 (p xix). Storage per capita in different semi-arid countries [Figure 9].*

The two largest dams in Pakistan are Mangla and Tarbela, with heights of 143 metres and 147 metres respectively. They were constructed to provide water for irrigation, power

¹¹ See International Commission on Large Dams here: http://www.icold-cigb.net/article/GB/world_register/general_synthesis/number-of-dams-by-country-members.

generation and flood control and have served their purpose well. However, at present, they face serious issues. The Tarbela dam, for instance, was built on the River Indus, which carries with it high volumes of silt. Over time, the build-up of silt has reduced the dam's storage capacity by 30 per cent since its commissioning more than 41 years ago.¹² Mangla Dam, constructed even earlier, in 1967, faces the same problems.

Progress on constructing additional water storage infrastructure has been slow. Primarily, this is because dams are a highly contentious issue in Pakistan. Construction has been repeatedly blocked due to inter-provincial conflicts and political pressures. For instance, the Kalabagh dam was proposed to be built in Mianwali district of Punjab province and would have generated 3,600 MW of electricity with a gross storage capacity of 7.9 MAF. However, the dam has not been constructed due to intense opposition from Sindh and Khyber Pakhtunkhwa provinces on water distribution issues. Similarly, the Diamer-Bhasha dam to be built on the Indus River was slated as one of the highest earth-filled dams in the world. After construction, it would provide 8.1 MAF gross storage and generate 4,500 MW. However, the government has not been able to finalise land acquisition for the construction to start. The conflict is over an eight-kilometre piece of land which belongs to rival tribes based in the area and backed by the governments of Khyber Pakhtunkhwa and Gilgit Baltistan.¹³

Along with construction of new dams, maintenance of existing ones is a long-standing issue, which directly affects the storage capacity. Large dams in Pakistan are constructed through funding from international donor organisations (grants and loans), especially the World Bank and the Asian Development Bank. Maintenance and operational costs of the dam are not included in funding. Therefore, as they age, their cost of maintenance increases and the institutions responsible are unable to garner enough resources for the upkeep of these dams. As a result, they deteriorate and function at sub-optimal levels.

Pakistan urgently needs water storage infrastructure to meet its current and future water requirements. Large dams such as Kalabagh and Diamer-Bhasha may be controversial, but they cannot be ignored as they are needed not just for storing water but also for hydropower. While governments build consensus around them, small dams, reservoirs, underground or

¹² The Indus River and Agriculture in Pakistan. (2015). *Water Politics*. Retrieved from <http://www.waterpolitics.com/2015/12/08/the-indus-river-and-agriculture-in-pakistan/>.

¹³ Khan, M. (2017). *Pakistan's biggest dam stymied by land dispute. The Third Pole*. Retrieved from <https://www.thethirdpole.net/2016/07/11/pakistans-biggest-dam-stymied-by-land-dispute/>

above-ground tanks are other possible storage options which can be built quickly while evading politicisation. They may also serve small-scale irrigation projects and control flooding on minor tributaries.

Defective Supply Network

An important aspect of supply management, often missed from the narrative, is the transmission of water. Pakistan suffers from both inadequate water supply infrastructure, leading to low water access,¹⁴ and defective infrastructure, causing high levels of water wastage.

Within irrigation, water losses occur primarily through main branch canals, distributaries and minors and water courses. They are estimated to be about 61 per cent of the total water diverted into major canals for irrigation purposes (Yu, et al., 2013). Data for provinces is not widely available, but Punjab government officials estimate that the delivery capacity of canals is 30 per cent below design because of the cumulative effect of deferred maintenance and lack of rehabilitation (Briscoe & Qamar, 2005).

Water losses present a huge cost to the state. Dr Simi Kamal estimates that, given a total surface water supply of 114 MAF diverted for use in agriculture and other uses, two-thirds or approximately 76 MAF is lost due to poor transmission and seepage in the canal system. This means 76 MAF can be regained if the canals and pipes are repaired (Kamal, 2009). To put it into perspective, the Kalabagh and Diamer-Bhasha dams will together add 16 MAF to water supply of which only 5.3 MAF will be actually available (two-thirds are lost). However, if only one-quarter of the 76 MAF of wasted water is regained, it will add over 19 MAF to the country's water supply.

Karachi, Pakistan's largest city, provides insights on the problem of wastage in urban water management. Leakages, water theft and out of order machinery plague the distribution system. As a result, the potential supply of 648 Million Gallons Daily (MGD) to the city is

¹⁴ A country has low water access if less than 75 per cent of the population has access to either safe drinking water or improved water sanitation.

reduced by 36 per cent or 210 MGD against a demand of 1,000 MGD from residential and commercial users.¹⁵

Lack of Alternative Sources

Water supplies from rivers, rainfall and groundwater are under pressure due to the effects of climate change, high population growth and urbanisation. Pakistan has already begun to experience the effects of climate change, with some parts of the country suffering from persistent drought while others suffer from floods. Sindh's Thar desert, for instance, has been affected since 2013, leading to the death of over 1,000 people and 4,000 animals and widespread devastation of agriculture.

In such a scenario, water management policies are misplaced. For instance, in response to the drought in Tharparkar region, the Sindh government introduced water treatment plants¹⁶ as an alternative source of water. This initiative ignored fundamental understanding of the region and the issues it faces. In an area with dispersed populations, access to water is not made easier by the treatment plants since users still need to travel to the plant to get water. In addition, the plants are costly to set up and maintain. The shallow groundwater aquifers in the region are also not sustainable sources of water. Consequently, after a year of usage, there were reports of brackish water being supplied to the users.¹⁷ Instead, the government needed to focus on sustainable alternative systems, for example, constructing a network of canals and pipes to reach communities or a multitude of rain-water storage tanks spread across the region.

Alternate sources of supply include recycled or reclaimed water. These options are currently not explored in Pakistan but lessons can be learnt from Singapore, which is also a water-stressed country. Singapore has invested in recycled water to reduce its dependency on water from Malaysia and to meet the growing needs of its population. It is also 100 per cent seweraged to collect all used water. Similarly, Pakistan must explore and invest in reclaimed

¹⁵ Kaleem, M., & Ahmed, M. (2016). Tapping into trouble. *Herald*, (August 2014). Retrieved from <http://herald.dawn.com/news/1152875>.

¹⁶ Reverse osmosis plants treat dirty groundwater through membrane technology and make it suitable for human consumption.

¹⁷ Ebrahim, Z. (2015). Expensive water plants won't quench thirst in Pakistan's Thar desert. *The Third Pole*. Retrieved from <https://www.thethirdpole.net/2015/01/27/expensive-water-plants-wont-quench-thirst-in-pakistans-thar-desert/>.

water. Reclamation will need investment in technology and separation of drainage and sewerage systems to facilitate the usage of wastewater on a large scale. Singapore's experience of using both desalinated and reclaimed water shows that the production cost of recycled water is less than that of desalinated water (Tortajada 2006). Thus, reclaimed water is one way for Pakistan to expand and better manage its water supplies.

Demand-side

Water demand in Pakistan emanates from agriculture, household and commercial users. Irrigation and agriculture are responsible for approximately 97 per cent of total water resources with remaining three per cent allocated between household and commercial users. Two key factors affecting demand explain the water management issues in Pakistan – agriculture water use inefficiency and the low price of water. These are discussed in detail below.

Agriculture Water Use Inefficiency

According to IMF estimates, Pakistan has the fourth-highest rate of water use in the world. The water intensity rate¹⁸ is the highest in the world (IMF, 2015). This inefficiency stems primarily from agriculture – the biggest consumer of water in the country. Three factors discussed below explain how this happens:

i) Water-intensive crops

The main crops grown in Pakistan are cotton, wheat, rice, maize and sugar cane. These are water-intensive crops. As indicated in Table 1, the highest net water requirements per hectare are for sugar cane, followed by rice and cotton and wheat. On a per hectare level, sugar cane uses 2.9 times more water than wheat, 1.8 times more than cotton and 1.2 times more than rice. Compared to its water use, sugar cane has the lowest farm gate price per kg of product.

While consuming high amounts of water, these crops produce lower average yields in Pakistan compared to international producers. For example, the wheat yield of Punjab in

¹⁸ Water intensity is the amount of water used per unit of GDP. In the case of Pakistan, high water intensity indicates low efficiency in water use.

Pakistan is half that of Punjab in India. It is 2 tons/hectare, compared to almost 4 tons/hectare in India (Khan, 2009).¹⁹ Similarly, the average yield of 47.5 tons/hectare for sugar cane in Pakistan is among the lowest in the world, compared to a world average of 62.5 tons/hectare (Khan, 2009).

Table 1: Water Requirements of Main Crops Grown in Pakistan

Crop	Net Water Requirements per hectare (m ³)	Yield Per Hectare (kg)	Water Requirements (m ³) for Producing 1 kg	Farm gate price of 1 kg of Product
Wheat	4,050	2,388	1.70	9.33
Rice	10,260	2,013	5.10	9.54
Sugar cane	11,810	47,300	0.25	1.01
Cotton	6,500	622	10.45	20.79

Source: Amir 2005 (p 13). *Water Requirements Equivalent of Crop Production [Table 3]*.

Despite the high water requirements and low yields, these crops continue to be grown in Pakistan because they are seen as “high-value crops”. The government supports farmers through subsidies and support prices that further encourage the cultivation of these crops, preventing farmers from diversifying or moving to less water-intensive crops. Political motivations also play a key role in what crops are grown. For instance, large landowners in Sindh and Punjab grow sugar cane on their land and also own sugar mills. In the 1990s, civilian governments favoured subsidised loans for building sugar mills in order to benefit major equipment suppliers for sugar mills (Khan, 2009). Policies such as this have resulted in a 45 per cent excess refining capacity of sugar mills and an insistence on growing a crop that is highly water-intensive, very sensitive to water salinity (growing problem in Pakistan as water tables fall) and has extremely low sugar recovery rate.²⁰

¹⁹ In terms of per unit of water used, wheat yield in Pakistani Punjab is 0.5 kg/m³, compared to 1 kg/m³ in Indian Punjab.

²⁰ Sugar recovery is the percentage of sugar produced to the sugarcane crushed (in metric tons). In Pakistan the rate is close to 8 per cent, compared with an international average of 12-14 per cent. See Dawn, ‘How to improve sugar recovery from cane?’ <https://www.dawn.com/news/299048>

ii) Traditional irrigation methods

The type of irrigation method used directly impacts water usage. In Pakistan, approximately 30-40 per cent of the area is irrigated from surface water²¹ which is applied through basin, furrow and border irrigation methods. Widely utilised and requiring little operational know-how, they are less efficient as evaporation and surface runoff are standard problems and lead to water wastage.

The water distribution system for irrigation is also problematic. Water is released from a dam and flows through canals and distributaries to reach the final irrigation channel, also called the 'watercourse'. From the watercourse, each farmer takes his turn according to the 'warabandi' system. Warabandi means turns (warh) which are fixed (bandi) (Khan, 2009). The cycle begins at the head and proceeds to the tail of the watercourse, and during each turn, the farmer has the right to use all the water flowing to the watercourse. The turns come on a specific day when the fields can be irrigated. This encourages overuse, especially by those at the head of the watercourse. As a result, water is used inefficiently and tail-end users get less than those before them. Often, they get no water at all, relying instead on other sources of supply.

iii) Tube wells and water pumps

Declining surface water availability and subsidies by successive governments encouraged the installation of tube wells in Pakistan. These subsidies were meant to increase agricultural yields and also helped reduce the price of inputs, including the cost of electricity.

While such subsidies increased agricultural production, they also led to a massive decline in water tables in most canal command areas of Punjab and Sindh. In a period of 40 years, the number of tube wells increased from 10,000 in 1960 to approximately 600,000 in 2003. This unchecked installation of tube wells was followed by the indiscriminate pumping of water, leading to the rapid depletion of groundwater. For instance, Lahore has seen the water table drop 0.5 metres annually for the past 30 years (Khan, 2009). This depletion has occurred in spite of the fact that Lahore is next to the River Ravi and has multiple major canals which

²¹ Estimates suggest that approximately 20 per cent of the area under irrigation uses groundwater and over 40 per cent utilises both surface and groundwater.

could help in replenishment. In Quetta, the water table has been dropping 3.5 metres annually and estimates suggest that it may run dry by 2018 (Khan, 2009).

At the same time, the quality of groundwater is falling as well. Excessive pumping and heavy usage of pesticides have resulted in contamination of the aquifer at many places and the salinity of tube well water has increased. Saline water used in agriculture decreases productivity and also leaves large tracts of land unusable for growing crops. Estimates suggest that 13 per cent of the cultivated land in Pakistan is saline. Water logging and salinity combined have led to a decline of approximately 30 per cent in yields of major crops (Siegmann & Shezad 2006).

Low Price of Water

In Pakistan, water is priced below cost. Deemed as a free public good, it does not reflect the economic value of water and its scarcity. Discussed below, both agriculture and household usage are impacted by the price of water.

i) Agriculture

Canal water is heavily under-priced in Pakistan. As a result, efficient water use is not encouraged and the government is unable to collect sufficient revenues for upgrading or operations and maintenance of the irrigation infrastructure.

Farmers are charged a water-use fee, essentially a service delivery charge for water supplied through the irrigation network. It is based on the area cultivated and crops grown. This charge called 'Abiana' in Pakistan is collected by the revenue department of each province. Provinces can adopt either flat or differential Abiana rates. For instance, Punjab introduced the flat-rate system in 2003 by fixing the water charges for Kharif season crops (sugar cane, rice, cotton and maize) at US\$0.81 (S\$1.10) per acre²² and for Rabi season crops (Wheat, oilseed, vegetables) at US\$0.47 (S\$0.64) per acre. Khyber-Pakhtunkhwa introduced the flat-rate system in 2008 and increased it in 2009 to US\$1.90 (S\$2.59) per acre for food crops and US\$2.37 (S\$3.23) per acre for other crops. Sindh and Balochistan on the other hand, rely on

²² Acre is a unit of land measurement, where 1 acre is 40 per cent of 1 hectare, or 2.47 acres equal 1 hectare.

differential rates for crops. Balochistan has been particularly effective in raising Abiana rates, which are subject to an annual 13 per cent increase. They are also the highest across all four provinces and reflective of water intensity of the crop. For example, the sugar cane rate is US\$1.72 (S\$2.34) per acre and cotton is US\$0.84 (S\$1.14) per acre, as sugar cane uses 1.8 times more water than cotton (Planning Commission, 2012).

A strong agricultural lobby has meant that Abiana rates have remained unchanged. Punjab's decision to change from differential to flat rates was historic, as the differential rates had essentially remained unchanged since the 1970s. The previous system was often manipulated by influential farmers and revenue officers, who misreported the type of crop grown, for example, recording a low-value crop while growing high-value ones such as rice or cotton.²³ The high level of discretion given to revenue officers led to a rent-seeking behaviour. The flat-rate system takes away this discretion and room for misreporting while reducing administrative expenses. However, from the point of view of water conservation, the flat-rate system does not reflect water consumption by crops, i.e. rice and sugar cane are charged the same in Kharif season, though their water requirements are very different.

The government's revenue is impacted in two ways: low water charges and low recovery.²⁴ As a result, at present, revenues cover only about 24 per cent of the annual operating and maintenance costs. At the national level, Abiana collection is averaging 60 per cent of the assessed amount (of receivables), leading to a loss of US\$11.4 million (S\$15.54 million) annually at the national level (Planning Commission, 2012).

Irrigation budgets are spent primarily on salaries, allowances, transportation or lost in corruption. Thus, little remains for spending on maintenance and upgradation. In Punjab, irrigation infrastructure is valued at approximately US\$20 billion (SG\$ 27.27 billion), which requires an annual replacement and maintenance budget of US\$0.6 billion (S\$0.82 billion), based on international benchmarks (Briscoe & Qamar 2005). The actual budget for replacement and maintenance is only US\$0.2 billion (S\$0.27 billion) and 76 per cent of the total irrigation budget is spent on personnel (Briscoe & Qamar 2005). In addition, most of the funds allocated for maintenance are spent on de-silting of canals and minor repair works. The

²³ Dawn. (2004). Abiana: flat or differential rate?. Retrieved from <https://www.dawn.com/news/390743>.

²⁴ Low recovery means revenue officials are not collecting 100 per cent of assessed amount.

bulk of maintenance is postponed to the future. Consequently, the irrigation system continues its downward trajectory.

ii) Households

A high percentage of domestic consumers across the country have unmetered connections. Their consumption cannot be monitored, nor can they be encouraged to conserve water through fixing of leaky pipes, reducing water usage on non-essentials such as washing cars, gardening, etc.

The impact of price can be studied on metered households where pricing is based on a variable and fixed tariff structure. The fixed part includes monthly connection fee and a flat charge. The variable part consists of ascending volumetric blocks. The volumetric-based charges are divided into three ascending blocks and consumption is charged higher than on the previous block. There are two concerns: firstly, these tariffs are lower than the cost of provision. Secondly, initial blocks are very large and the majority of households fall in the first two blocks – consumption up to 5000 gallons and between 5,001 to 20,000 gallons (Rauf & Siddiqi, 2009). This tariff structure does not support cost recovery or the generation of revenue necessary to maintain and upgrade the existing water supply infrastructure in Lahore.

Additional water use is cheap. Therefore, households tend to use the maximum amount supplied to them. The primary way in which water utilities across Pakistan regulate water usage is through supply disruptions (reduction in hours of service) with rural areas (with piped water connections) facing more disruptions than urban areas. This unreliability pushes consumers to use water storage tanks and supplement supply by installing pumps to extract the available groundwater as well.

Not a lot of work has been done on residential water use in Pakistan and what factors, if any, affect household water demand. However, a recent study of 1,200 urban households in Faisalabad city was undertaken to understand the impact of water price on the quantity demanded. The study found that in response to a price change, demand remained price inelastic across all consumer groups. Their estimates of a price change on quantity demanded ranged from 0.20 to 0.45. This suggests that a one per cent increase in price is expected to bring a 0.20 per cent to 0.45 per cent decline in quantity demanded of water (Ahmad, Mirza,

Ali, & Lotia, 2016). The results are indicative of two issues. Firstly, the low elasticity confirms the premise that water charges are very low and households do not see the water expense as a significant part of their total budget. Secondly, other initiatives will be necessary to decrease water wastage and inculcate habits of water conservation (reduce demand), but the water charges can still be increased to raise revenues, recover costs and thereby generate income to improve and maintain water infrastructure.

The case of Karachi shows that, given water shortages, households are willing to pay more to get a consistent supply. The Karachi Water and Sewerage Board sanctions hydrants across the city to supply to underserved areas or localities where piped water is facing delivery issues. There are approximately 20 legally sanctioned hydrants and 125 illegally sanctioned hydrants in Karachi. Contractors of these hydrants acquire water (sometimes beyond the legal limit) and then supply to users at two-three times the actual price.²⁵

Conclusion

Pakistan suffers from an acute shortage of water, amplified by the forces of climate change and a growing population. While the country's economy remains highly dependent on water, management practices have not been in step with the challenge of scarcity.

Federal and provincial institutions manage water, guided by their respective national and provincial policies. These policies then translate into supply and demand management practices. In Pakistan, the complex institutional framework is defined by large bureaucracies, poor coordination and overlap among the federal and provincial agencies, along with an increasing dearth of resources – funds and technical expertise. At the same time, policies are either non-existent or wholly inadequate in providing vision and direction for steering the country out of water scarcity. The national water policy is yet to be implemented, existing in draft form for the past 14 years.

Water resource management is comprised of supply and demand practices. Countries that have been successful in water management are those that find the right balance between

²⁵ Kaleem, M., & Ahmed, M. (2016). Tapping into trouble. *Herald*, (August 2014). Retrieved from <http://herald.dawn.com/news/1152875>

demand and supply. As this paper analyses, Pakistan faces problems of water storage infrastructure, pricing that does not reflect the economic value of water, two-thirds system losses during supply due to defective infrastructure, large-scale inefficiencies in agriculture water use, absence of water metering at the household level and lack of innovation in developing alternative sources of supply. Initiatives, whether in the form of legal and regulatory reforms or, for example, alterations to the Abiana rates for agriculture users have been far too few and top-down approaches have suffered from implementation problems.

Pakistan needs to look within to drastically reassess its approach to water management. Water management and the current crisis are internal problems, separate from water-sharing issues with India. While their importance is acknowledged, a single-minded focus on enhancing water storage infrastructure through building large dams alone is counter-productive. The country needs an overhaul of federal and provincial institutions that manage water along with a national water policy that provides strategic direction and achieves a balance between supply and demand management practices.

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