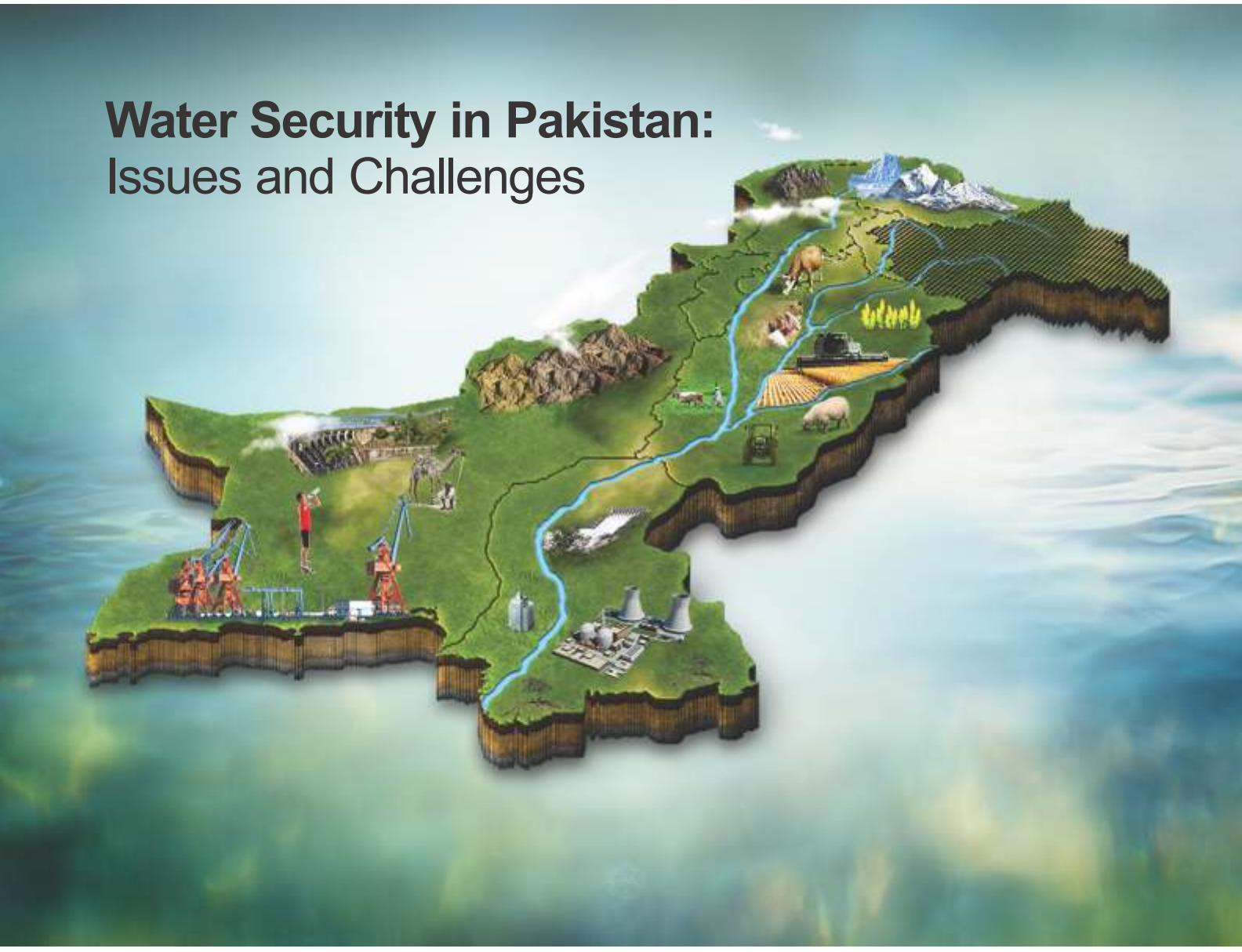
DEVELOPMENT ADVOCATE PAKISTAN

Volume 3, Issue 4

Water Security in Pakistan:
Issues and Challenges



DEVELOPMENT ADVOCATE
PAKISTAN

UNDP Pakistan

Development Advocate Pakistan provides a platform for the exchange of ideas on key development issues and challenges in Pakistan. Focusing on a specific development theme in each edition, this quarterly publication fosters public discourse and presents varying perspectives from civil society, academia, government and development partners. The publication makes an explicit effort to include the voices of women and youth in the ongoing discourse. A combination of analysis and public opinion articles promote and inform debate on development ideas while presenting up-to-date information.

DEVELOPMENT ADVOCATE PAKISTAN

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Design and Layout
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Printed by:
Maryah Printers, Islamabad

United Nations Development Programme Pakistan
4th Floor, Serena Business Complex,
Khayaban-e-Suharwardy, Sector G-5/1,
P. O. Box 1051,
Islamabad, Pakistan

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ISBN: 969-978-8736-16-3

December 2016

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Water Security: Pakistan's most Critical Development Challenge

"Water is not only for life … water is life." This quote by the United Nations Secretary-General reflects the critical importance of water as a need that connects all aspects of human life. People's well-being and their economic development are profoundly linked to the availability and usability of water. Too little water at a time when it is needed most, can mean drought and food insecurity. Too much water—in the form of floods or storms—can devastate an entire population. Contaminated water, whether from human or industrial sources, claims the lives of children and affects the health of communities worldwide, with far-reaching consequences.

It is in the context of this interconnection of water with other development challenges that the Sustainable Development Goals (SDGs) place great emphasis on ensuring availability and sustainable management of water. This includes achieving universal and equitable access to safe and affordable drinking water, sanitation and hygiene for all, and ending open defecation with special attention given to the needs of women and girls. But while that is crucial, especially in Pakistan, water's place in the SDGs go well beyond access—taking into account critical issues such as integrated water resources management, efficiency of use, water quality, transboundary cooperation, water-related ecosystems, and water-related disasters.

Water associated problems are amongst the key challenges faced by Pakistan. Pakistan's water profile has changed drastically from being a water abundant country, to one experiencing water stress. Between 1990 and 2015, per capita water availability declined from 2,172 cubic metres per inhabitant, to 1,306 cubic metres per inhabitant. Pakistan extracts 74.3 percent of its fresh water annually thereby exerting tremendous pressure upon renewable water resources. Despite remarkable improvements in the proportion of population using an improved water source and an improved sanitation facility, 27.2 million Pakistanis do not have access to safe water and 52.7 million do not have access to adequate sanitation facilities. The repercussions on health are severe: an approximate 39,000 children under five die every year from diarrhea caused by unsafe water and poor sanitation. Furthermore, with the increasing burden on water resources threats will increase to Pakistani's well-being from unsafe or inadequate water supplies.

Increasing demand for water and its erratic supply together are resulting in water shortages. Population growth, rapid urbanization, water intensive farming practices and industrialization all contribute to Pakistan's increasing demand for more water. Simultaneously, the supply side is hampered by climatic changes that have made rainfall more erratic, leading to floods in some years and droughts in others. Excessive pumping of groundwater has raised major concerns over its sustainability. Poor water infrastructure including limited storage capacity and inadequate linings of canals further compounds the situation of water availability. Pollution of available resources mainly due to contaminated agricultural run-offs and untreated industrial and household waste being dumped in water courses, is another factor leading to dwindling freshwater supply.

Over the years, there were several attempts at both Federal and Provincial levels to delineate the government's commitment towards combating water issues. The National Climate Change Policy, for example, has provided appropriate action plans focusing on enhancing water storage and infrastructure, better water resource management, enhancing institutional capacities and creating awareness. However, more is needed in terms of implementation. Since the commissioning of the Mangla and Tarbela dams in the 1960's and 1970's respectively, Pakistan has not developed any major water storage infrastructure. Consequently, water storage capacity has often receded to less than 30 days against the minimum requirement of 120 days. Successful initiatives do exist, such as the 'Clean Drinking Water for All' project launched in Punjab, providing clean drinking water through installation of water filtration plants, but major initiatives for provision of water and sanitation remain limited.

Addressing water issues require interventions at individual and state levels, focusing on both demand and supply. At an individual level, households and industries need to use water more efficiently and judiciously. This also holds true for the agriculture sector, whereby flood irrigation and plantation of water intensive crop should be controlled and regulated. In this regard, public education campaigns that focus on enhancing water usage awareness will be helpful. At a broader level, an integrated water management system is needed that promises efficient water distribution for all sub-sectors. This needs to be formally entrenched through an effective institutional and legal system. While water related issues have been discussed as part of the National Climate Change Policy and National Drinking Water Policy, a holistic national water policy is required. Water pricing to promote efficient use of water, building water storage infrastructure to store excess water, enforcing strict water quality management systems to curb water pollution, controlling population growth and adopting a sustainable pattern of urbanization, are all major issues that require immediate attention if Pakistanis are to have access to the water they need in the future. Bold actions are needed to address this water crisis, otherwise not only will Pakistan not meet the SDGs on water, but it future development will be hampered.

Water Sector of Pakistan: A Situational Analysis

Note: Major analysis has been conducted by Dr. Shahid Ahmad, a Water Resources Development and Management Expert.

Pakistan Water Vulnerability Assessment

Water Availability

Water availability in Pakistan is largely from precipitation (rainfall and snow), river flows from snow and glacier-melt and runoff from summer and winter rains from the watersheds. Some of the water from precipitation and surface water flows recharge the aquifer in terms of large storage of groundwater in the Indus basin. Pakistan benefits a great deal from all these sources of water and the availability of precipitation and river flows, marked by unique temporal variability. For example, the variability in the historical maxima and minima is 170.1 and 92.6 MAF, thereby indicating the distribution of floods and droughts in the Indus basin. The extreme variability in river flows makes resource management quite complex. Similarly, the recharge to the aquifer and availability of groundwater is also dependent upon the probability of wet and dry years. The trends of water availability in the Indus basin covering western and eastern tributaries are presented in Table 1.

Table 1: Trend of Indus River historical flows in million acre feet (MAF)

No.	Year	Indus River Flows (MAF)
1	1937-38	156.7
2	1940-41	130.5
3	1950-51	183.4
4	1960-61	178.2
5	1970-71	128.3
6	1980-81	134.7
7	1990-91	163.5
8	2000-01	97.6
9	2010-11	157.0
10	2012-13	121.5
Average Flows		147.8
Minimum Flows		92.65
Maximum Flows		207.70

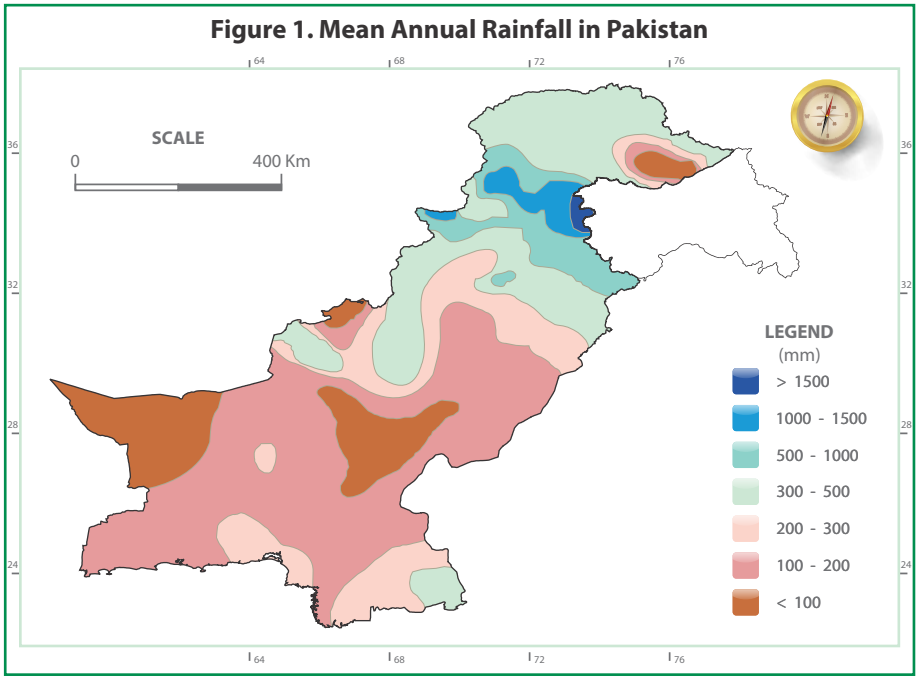
Precipitation

Mean annual rainfall varies from less than 100 mm in parts of Balochistan and Sindh, to more than 1500 mm in wet mountains. In Gilgit-Baltistan (GB), at altitudes exceeding 5000 m, snowfall exceeds 5000 mm and provides the largest resource of water in the glaciated zone (Figure 1). About 60 percent of rainfall is received during July-September. Contribution of rainwater to crops in the Indus Basin Irrigation System (IBIS) is 13.4 MAF, which is 13.5 percent of the mean annual canal diversions in the post-Tarbela period.[1] Extreme variability in seasonal rainfall has direct impacts on the river flows. Ninety-two percent of country's area is classified as semi-arid to arid.[2]

Glaciers and snow deposits

GB contains the largest area of perennial glaciers outside the polar regions (22,000 km^2) and estimates are that as much as 28

Figure 1. Mean Annual Rainfall in Pakistan



Source: Pakistan Met Department and WRRI, NARC, 1999

1 Ahmad, S. 2008a. Land and water resources of Pakistan – A critical appraisal. Paper presented in 23rd Annual General Meeting & Conference of Pakistan Society of Development Economists (PSDE). Broad theme of 'Natural Resource Management: Issues and Challenges'. Islamabad, Pakistan

2 Ibid

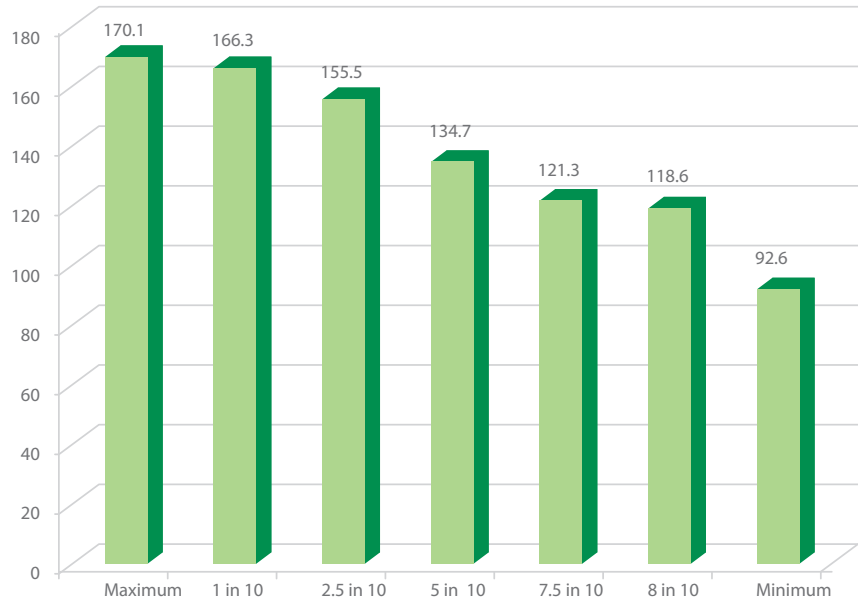
percent of the region is glaciated, and winter snow cover occupies up to 30-40 percent of that area. More than a 100 glaciers stretch over 10 km in length, with several extending beyond 50 km. Hence, glaciers and seasonal snow constitute a huge reservoir for freshwater in the area and contribute vastly to the flow of the Indus river.[3]

Indus river system flows – post-storage era

Seasonal, annual and daily river flows in the Indus river system are highly variable.[4] River flows are generally limited in the Rabi[5] season because of limited glaciers, snow-melt and rainfall, with flows increasing by almost five times in the Kharif season. During 1975-2013, western rivers contributed nearly 134.7 MAF of water in a median year (50 percent probability). After the construction of Mangla and Tarbela dams, eastern rivers contributed 7.0 MAF of water in a median year, of which 80 percent was in the Kharif season. Total median annual flows from both western and eastern rivers was 141.7 MAF (Figure 2).

Variability in river flows during droughts has given rise to water crises and fuels inter-provincial water conflicts. The Water Apportionment Accord, based on the mean annual river flows of 143 MAF, indicates that the apportioned amount of water will not be available to provinces in one out of two years.

Figure 2: Probability of Indus basin river flows (MAF) during 1975-2013



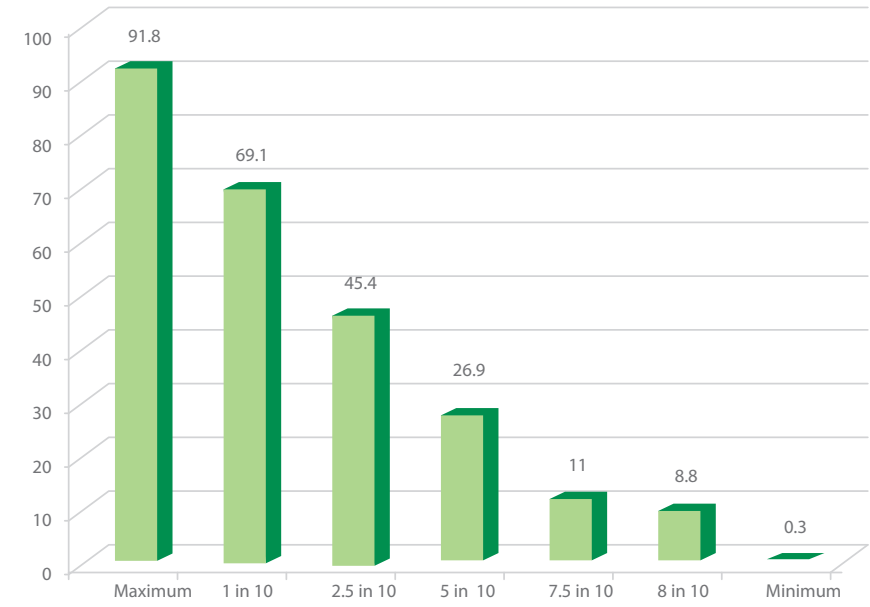
Source: IRSA 2016

Flows to Arabian Sea – downstream of Kotri Barrage

Annual variability of river flows downstream Kotri barrage has been very high. In the median year, annual flow was 26.9 MAF during 1975-2013. In one out of ten years, the flows below Kotri are almost negligible (Figure 3). The construction of Kotri barrage reduced seasonal and annual flows below Kotri owing to enhanced canal diversions. Seasonal and annual flows were further reduced during the post-Mangla and post-Tarbela periods due to increases in canal diversions at Kotri and upstream commands.

A clearer picture emerges with an analysis made of the number of days per season when flows downstream of Kotri barrage were zero. In pre-Kotri period (1956-61), there was not a single day with a zero flow. In post-Kotri period (1961-67), the maximum number of days with zero flows in Rabi season were 10. 1975-2013 saw the highest number of zero flows in the Rabi season at 180 (Figure 4). In post Kotri/Mangla periods, zero flows were on average 33 days in the Rabi season, whereas in the post-Tarbela period zero flows were on average 81 days.[6]

Figure 3: Probability of river flows (MAF) below Kotri Barrage



Source: IRSA 2016

Per capita surface water availability and storage

Per capita designed live storage capacity available in Pakistan is 121 m^3 per person, which is only higher than that of Ethiopia. USA houses the largest storage capacity of 6000 m^3 per person, followed by Australia and China. When compared with a storage capacity of 900 days in the Colorado River, USA, Pakistan stands with a storage capacity at a mere 30 days.

Groundwater recharge

Estimated annual recharge to groundwater in the IBIS is 55 MAF, out of which 36 MAF occurs in the freshwater zone.[7] The 1979 basin-wide survey of WAPDA indicated that the water table, covering a 42 percent area of IBIS, was below three metres and classified as waterlogged. Owing to

3 Ahmed, S. and M. F. Joyia. 2003. Northern Areas Sustainable Development Strategy. NASDS Background Paper: Water IUCN Pakistan, Northern Areas Progamme, Gilgit. xiv+67 pp.

4 Ahmad, S. 1999. Achievements and issues of irrigation in the 20th century. Proceedings of the National Workshop on "Water Resources Achievements and Issues in the 20th Century and Challenge of the Next Millennium", Islamabad. PCRWR/UNESCO, June 28-30, p. 188-201.

5 The cropping season is classified into two main seasons-(i) Kharif and (ii) Rabi, based on the monsoon. The kharif cropping season is from July –October during the south-west monsoon and the Rabi cropping season is from October-March (winter).

6 WCD. 2000. Tarbela Dam and related aspects of the Indus River Basin Pakistan. Final Report: November 2000. Prepared for the World Commission on Dams (WCD) by: Asianics Agro-Dev. International (Pvt) Ltd. Secretariat of the World Commission on Dams. Cape Town 8018, South Africa. Website: http://www.dams.org

7 Zuberi, F.A. and A.B.Sufi. 1992. State of art of groundwater exploration, exploitation, management and legislation. IWASRI, WAPDA, Lahore, 26 p.

drought and increased abstractions in 2003, the waterlogged area saw reductions from 42 to 32 percent. Although, data since 2003 is unavailable, however waterlogging is on a continual decline due to drought.[12]

In the IBIS, the total groundwater reservoir of fresh and marginal quality water measures to 810 MAF (gross command area of 16.7 million ha and depth of freshwater of 15 m), equivalent to six times that of mean annual river flows. Excessive pumping in a few dry years will not have lasting negative impacts on the resource, rather it will create a space for excessive recharge during wet years when flows are more than two-fold (225 percent higher) of the lowest flows, and 45 percent higher than the mean annual flows.

Groundwater abstraction

There are around 1.0 million tubewells energized either with electricity (18.5 percent) or diesel (81.5 percent). The abstraction of groundwater during 2013-14 was 50.2 MAF, which has remained stagnant for the last 15 years (Figure 5). A subsidy of PKR 28 billion per annum is provided on electric tariff for 30,000 tubewells in Balochistan (three percent of total tubewells). This had serious impacts on lowering of the water table in Balochistan and resulted in wasteful use of water and energy.

Major issues with regards to abstraction include,[13] a) Majority of available groundwater (90 percent) is abstracted and any development beyond 10 percent will result in rapid lowering of the water table; b) Farmers are now abstracting groundwater from brackish zones underlain by fresh groundwater which has resulted in intrusion of brackish groundwater into freshwater zones; c) Abstraction of groundwater is now resulting into redistribution of salts due to a lack of drainage; and, d) Rise in electric tariff will result in shifting to diesel-operated tubewells as a result of which, the profitability of farming will be affected by diesel prices.

In the last 40 years (1976-16), groundwater contribution to irrigated agriculture has doubled from 25.6 to 50.2 MAF[14] and it is currently stagnant. Groundwater now contributes 47 percent of surface water available at the farm head.

Multiple Uses of Water

The major sub-sectors of water use in Pakistan are domestic, agriculture, industry and environment. Although agriculture is the largest consumer of water, however, domestic water has been assigned a higher priority, given that drinking water is a basic necessity, and has been identified as a basic right as per the country's water strategy of 2012.

The agriculture sector consumes around 91.6 percent of the total annual water use in the country; followed by environment at 3.3, domestic at 2.6 and industry at 2.5 percent (Figure 6). Hence, water saving and efficient utilization of water in the agriculture sector is crucial, given that this sector demands the highest amount of water.

Table 2. Population and water availability in Pakistan

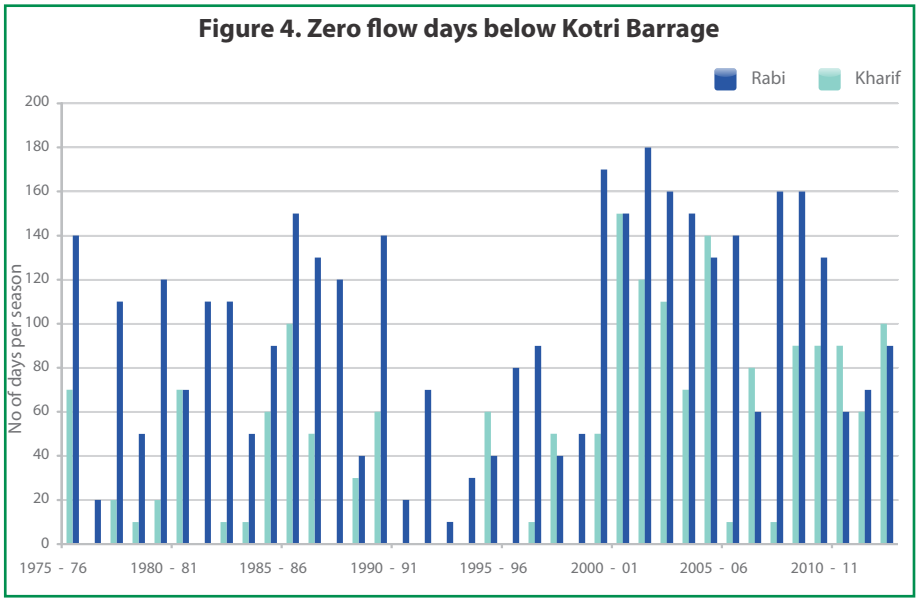
Parameter	Data at Pakistan Level
Population 1998 (millions)	132.35
Population 2016 (millions)	189.87[8]
River Flows (MAF)	144.7[9]
Floodwater outside Indus basin (MAF)[10]	22.0
Floodwater outside basin but drained to Indus River System (MAF)[11]	-10.7
Total Available Water (MAF)	156.0
Water Availability per Capita (m3/person/annum)	1014

Sources:

1. Ahmad, S. 2008a. Land and water resources of Pakistan – A critical appraisal. Paper presented in 23rd Annual General Meeting & Conference of Pakistan Society of Development Economists (PSDE). Broad theme of 'Natural Resource Management: Issues and Challenges'. Islamabad, Pakistan;

2. Ahmad, S. 2008b. Contribution to the Report of the Sub-Committee on Water and Climate Change. Task Force on Food Security. Planning Commission.

Figure 4. Zero flow days below Kotri Barrage



Source: IRSA 2014

Water use in the agriculture

Current water use

The largest infrastructural enterprise, the IBIS network, accounted for USD 300 billion worth of investment and contributed USD 21.2 billion, nearly 19.8 percent, to the country's GDP during 2015-16. Irrigated agriculture provides 90 percent of wheat and small grains, in addition to sugarcane, rice, cotton, fruits and vegetables, almost entirely. Apart from crops, the network also provides milk, meat and fuel-wood and is home to a majority of buffaloes.

Indus basin canal water supplies

Variability in annual canal diversions was from 111.1 to 76.2 MAF, representing a variability of 34.9 MAF between the highest and lowest canal water diversions. Thus,

8 Based on estimates made by the NIPS.

9 141.7 MAF of average annual river flows at rim stations and 3 MAF of water used by Civil Canals at upstream of rim stations

10 Using a runoff coefficient of 26% instead of 18% used by the NESPAK (1998).

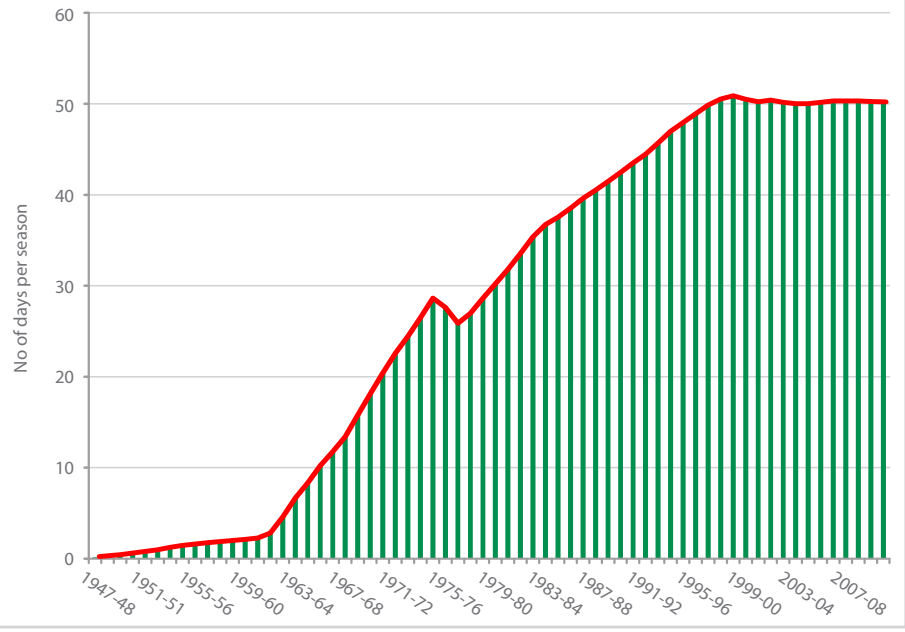
11 Using flows drained to Indus basin using current level of water use.

12 WAPDA. 2006. Waterlogging and salinity in the Indus basin. WAPDA, Lahore.

13 IWMI. 2010. Banking on groundwater in times of change. Colombo, Sri Lanka: International Water Management Institute (IWMI). 7p. (IWMI Water Policy Brief 032)

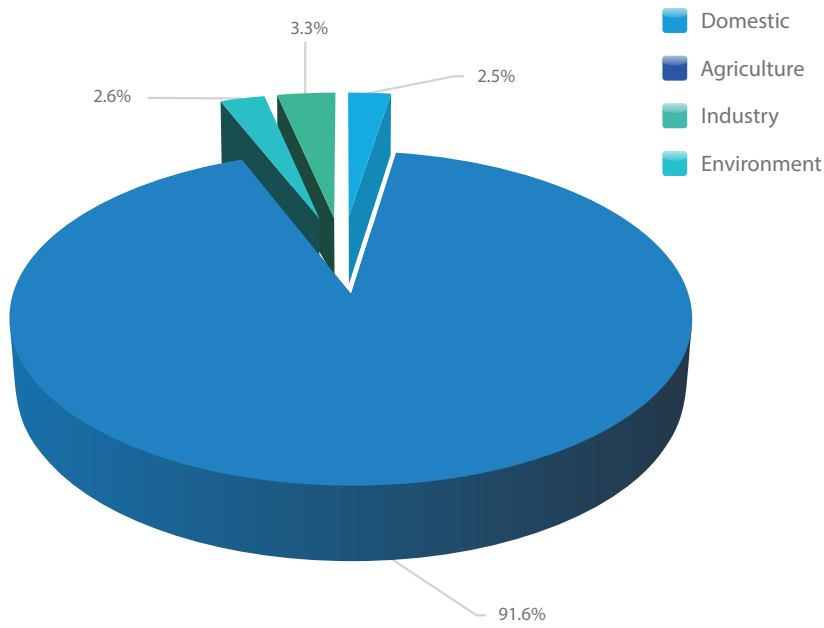
14 GOP 2016. Agriculture Statistics of Pakistan. Economic Wing of the Ministry of Food, Agriculture and Livestock, Government of Pakistan.

Figure 5: Groundwater abstraction in Pakistan



Source: Agricultural Statistics of Pakistan, Statistics Division, 2014

Figure 6: Water use by sub-sectors (2016)



Box 1: Budget of Agricultural Water Use in the IBIS

- Canal Diversions to IBIS at 50% probability - 101.84 MAF
  - ✓Water Conveyance losses - 45.52 MAF
- Canal Water Available at Farm Head - 56.32 MAF
- Pumpage from Groundwater during 2013-14 - 50.2 MAF
- Net Water Availability at Farm Head - 106.52 MAF
  - ✓Field Application Losses - 26.63 MAF
- Net Irrigation Water Availability for Crop Consumptive Requirement - 79-89 MAF
- Rainfall Contribution - 13.4 MAF
- Assuming that rainfall is equivalent to amount required for leaching fraction to maintain salt in IBIS, net water available - 79-89 MAF
- Net Crop Water Requirement - 101.7 MAF
- Shortfall in mean year at 50% probability without rainfall contribution - 21.81 MAF
- Shortfall during mean year at 50% probability with rainfall contribution of 13.4 MAF - 8.41 MAF

stochastic nature of river flows has a pronounced effect on canal diversions, instead of loss of storage capacity (Figure 7). The loss of storage capacity also has negative impacts on canal diversions.

The lowest canal diversion during 1975-2013 was 76.2 MAF which had adversely affected irrigated agriculture in the drought year. According to the Water Accord, 114.35 MAF of canal water supplies was apportioned to the provinces, considering that the construction of new dams (Kalabagh and Basha) will render additional storages. Probability of canal supplies during 1975-2013 indicated that apportioned water was never available as per Accord. The canal diversion in a median year was 101.84 MAF.

Current budget

Water conveyance efficiency of the IBIS is 55.3 percent based on canal and water-course conveyance efficiency of 79 and 70 percent, respectively. Field application efficiency is 75 percent. Thus, overall irrigation efficiency stands at 41.5 percent. The net water availability for crop consumptive requirement is 79.89 MAF, whereas net water requirement for crop consumptive use for existing cropping pattern in the IBIS is 101.7 MAF. With rainfall contribution of 13.4 MAF, the shortfall stands at 8.41 MAF (8.3 percent), and 21.81 MAF (21.4 percent) vice versa. The shortfall during dry years continues to increase due to reduced canal water supply and less rainfall. Farmers adapt either by reducing cropped area, deficit irrigation or enhanced abstractions from groundwater (Box I).

Balance Water Available for Carry Over Dams on Indus Main

The probability of balance water available in the Indus basin is presented in Figure 8. The probability indicates that a total of five-out-of-ten years' worth of water is available for storage in the reservoirs constructed on the Indus main. This would mean that in the future, storage dams can be constructed for storage of water for carryover dams. This would imply that the water stored in these dams during wet years, be provided in dry years to reduce the impacts of floods and droughts in the Indus basin. Such integrated efforts are needed to mitigate the risks of floods and droughts.

Future Water Demand

The country's current population stands at approximately 190 million (2016), due to increase to 217 million by 2025, using a growth rate of 1.5 percent per annum. Thus, an increase of 14.2 percent in water availability is needed to meet the requirement of the population in 2025. In order to meet the net crop water requirement, the demand of water would be 101.7 and 116.14 MAF for 2016 and 2025, respectively.

Issues and challenges

Water Availability and Scarcity

Water availability in the post-Accord period was significantly less when compared with Accord entitlements of 114.3 MAF of canal water supplies. Maximum amount of water diverted to canals during 1975-2013 was 111.1 MAF, with median year supplies of 101.84 MAF, which is 12.2 percent less than the Accord. Variability in canal water supplies ranges between 76.2 to 111.1 MAF, which is 33.3 and 2.9 percent less than the Accord and is creating water disputes among provinces.

The issue of sharing water shortages among provinces then remains, especially when they feel that their entitlements are as per the Accord. Also of pertinent concern, is the issue as to why water entitlements are higher than the availability of water itself. The reason is that these entitlements are based on the fact that additional storages will be constructed in the future, which have yet to be initiated. Although there have been past disputes on water distribution, however, the Indus River System Authority (IRSA) was successfully able to distribute water without any grievances, referred to by the Council of Common Interests (CCI).

The Indus Main houses an inadequate storage capacity incapable to regulate water supply ensuring that surpluses are not wasted and there is sufficient water to meet needs in times of shortage. Pakistan's water storage capacity ranges between 0 to 40 days of river flows during dry and wet years, respectively. Storage availability is around 18.6 MAF, which is insignificant to meet the future water demand and to ensure availability of water to provinces as per Accord. Pakistan's river flow hydrology is such that there is no water to store during the dry year, whereas the situation is opposite during wet years.

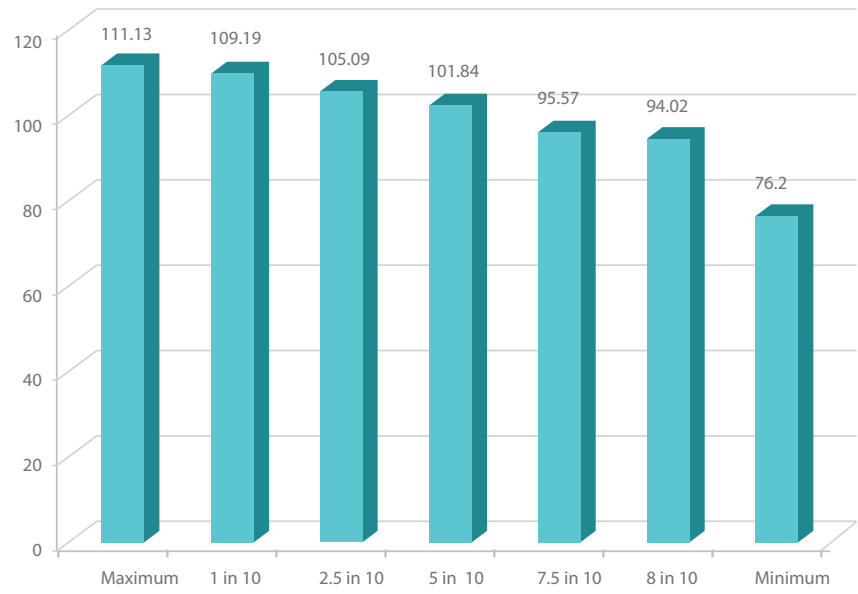
Rising and Competing Water Demand

The water demand continues to increase owing to a rise in population and a higher demand for multiple water uses. The water demand for domestic and industrial sub-sectors of water use will receive higher priority and compete with water required for agriculture. In case no new water resources are developed in the near future, rise in demand for domestic and industrial sectors would largely be met from water allocated and used for the agriculture sub-sector.

Inter-provincial Disputes and Water Apportionment Accord

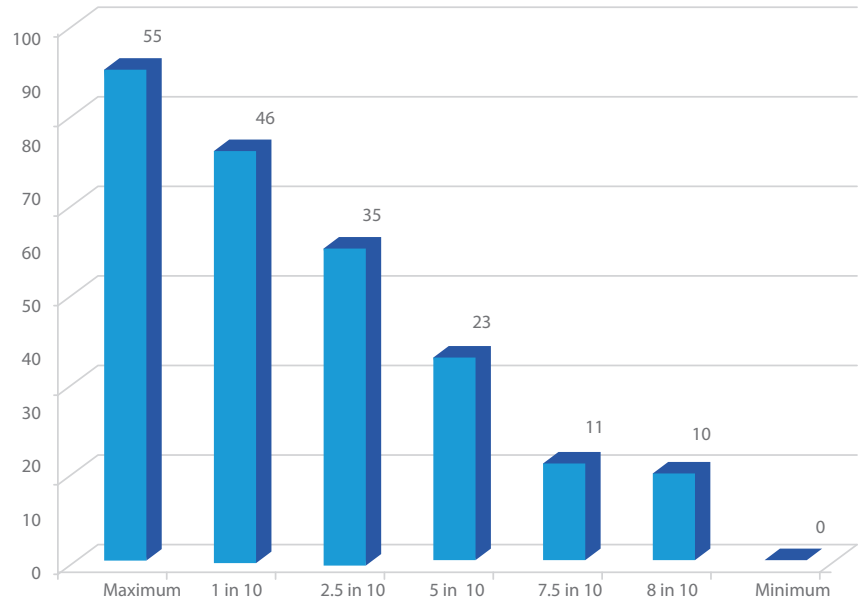
Inter-provincial water disputes continue to prevail on the division of water as per entitlements and sharing of shortages. Punjab and Sindh have been facing such disputes since pre-partition. Sindh and

Figure 7: Canal diversion (MAF) during 1975-2013



Source: IRSA 2016

Figure 8: Probability of balance water available for carryover dams on Indus Main in wet years



Source: IRSA 2014

Balochistan have also been facing similar disputes (Khirthar and Pat Feeder Canals), as Balochistan is a lower riparian of Sindh and is unable to utilize its due share of water owing to inadequate infrastructure. The question to be addressed then is regarding the utilization of the share of Balochistan. Provinces are not entitled to market their unutilized share of water as per the Accord, which is a limitation and may be rectified in the future. Transport of effluents to downstream and impacts of pollutants on bio-diversity and ecology of delta ecosystems, is now a serious concern.

Owing to a lack of enforcement of the formula for water distribution as per the Accord based on a ten-daily average use, system-wise and seasonally adjusted figures are still an unresolved issue. The province of Punjab (upper riparian) remains insistent on using figures during the 1977-82 period, in which, as per sentiments expressed by the Sindh province (lower riparian), adhoc allocations by the federal government have favoured Punjab. This looming mistrust regarding the proportionate distribution of water between lower and upper riparians, is an issue which needs to be resolved, with the former claiming that it has less water than its entitlement, and the latter bears reservations on the authenticity of water losses data between the barrages of Sindh.

The impact of reduced flows below the Kotri barrage on the livelihood of people dependent upon delta ecosystems including livelihood sources of fisheries, mangrove forests, livestock and delta

farming, are increasingly visible and significant. Findings of the study on "Water Escapage below Kotri Barrage" need to be considered and approved by the IRSA and CCI.

It is also worthy to note that with a rise in water demand owing to population growth and economic development, the future will see more national conflicts between regions who have not been allocated any share as per the Accord. These include the regions of Gilgit Baltistan, Federally Administered Tribal Areas, Azad Jammu & Kashmir, and Islamabad.

Environmental Flows (e-Flows)

Environmental flows are essential for providing water for nature. The most important e-flows in the IBIS are: a) Indus delta below Kotri barrage to maintain ecosystem and habitats; and b) Three eastern rivers flowing to Pakistan with the right to flow in order to maintain river ecosystems. The Water Accord provides entitlements for e-flows below Kotri and a study conducted estimated minimum e-flows there. Priority allocations for e-flows in times of droughts when water is not adequate to meet the demand of the agriculture sub-sector, is an issue that requires addressal. Thus, provinces will not assign high priority for minimum e-flows. The minimum e-flows for eastern rivers to Pakistan were not allocated and consequently the river has lost the right to flow in almost 335 days in a year, and water is available only during floods. This has had severe impacts on river ecosystems and the livelihood of local people. Even areas of dry rivers are facing difficulty in obtaining access to water for multiple uses. The resultant impact is the degradation of dry beds of the eastern rivers that lie in Pakistan.

Climate Change Impacts

Rapid climate change and global warming will have major impacts on increased crop water requirement. This will hamper productivity owing to changes in crop boundaries and reduced length of the growing season. Thus, the chances of reduced water availability during the dry years should be expected. Extremes will be more frequent and severe, which will have negative impacts on productivity and sustainability of irrigated agriculture. The real question is how to develop and test adaptations, as well as scaling up to mitigate the impacts of climate change on productivity.

Nexus with Food and Energy Security

Water and energy are major factors that affect food security. As almost half of water use for consumptive requirement in the IBIS is from groundwater, energy is and would play an important role in maintaining and sustaining the productivity and profitability of agriculture. There has been a continual rise in the price of diesel-fuel and tariff of electricity as there is no subsidy on diesel fuel. One thing is clear: efficient use of surface water will supplement the use of groundwater. The issue is how to maximize the efficiency of canal water use so that groundwater abstracted in the IBIS is reduced for maintaining an equilibrium in abstractions. Groundwater quality in upper Sindh, southern KPK and Southern Punjab is brackish. Thus, long-term food security can be achieved only through conjunctive and efficient use of surface and groundwater.

Management of Water – Quantity and Quality

The management of water in all sub-sectors is a major issue in the country. Both aspects of quantity and quality are important. The storage of water available in the country is at a bare minimum, with a capacity to store Indus water equivalent to 30-50 days of river flows in wet and dry years. Likewise, the efficiency and productivity of water use is extremely low owing to an almost negligible pricing of water. For example, domestic water bills in most urban areas go as low as PKR 500 and below per month. In agriculture, water fee for wheat varies from PKR 50 to PKR 100 in different provinces for one acre of land, during the wheat growing season. The cost of fertilizer utilized stands at approximately PKR 10,000 per acre. This delineates that water for agriculture is almost free.

Quality is also a serious concern. Sewage and industrial effluents in urban areas are mixed and the wastewater treatment facility is almost insignificant, with few treatment plants in operation. Sewage, industrial and agricultural effluents ultimately drain in to freshwater systems-canals and Indus River tributaries-and are ultimately used for raising fodders and vegetables in peri-urban areas. With water containing the presence of heavy metals, nitrogenous compounds and bacteria, it is no surprise that the soil and produce also get impacted. Research studies conducted by the Pakistan Agricultural Research Council (PARC) and many others have identified the produce as unsafe for human and animal consumption.

Water Management and Governance

Water as a main priority in the National Climate Change Policy

The National Climate Change Policy identified threats, while describing Pakistan's vulnerability to climate change including, a) Erratic monsoon rains causing frequent and intense floods and droughts; b) Projected recession of the Hindu Kush-Karakoram-Himalayan (HKH) glaciers due to global warming and carbon soot deposits from trans-boundary pollution sources, threatening water inflows into the Indus River System (IRS); c) Increased siltation of major dams caused by more frequent and intense floods; d) Rising temperatures resulting in enhanced heat and water-stressed conditions, particularly in arid and semi-arid regions, leading to reduced agricultural productivity; e) Increased intrusion of saline water in the Indus delta, adversely affecting coastal agriculture, mangroves and the breeding grounds of fish; and, f) Increased stress between upper riparian and lower riparian regions in relation to sharing of water resources.

The climate change policy emphasized how water would have the largest impacts as compared to any other sector in Pakistan. Thus, six action areas were identified for climate change adaptations in the water sector including, a) Water storage and infrastructure; b) Water conservation strategies; c) Integrated water resource management; d) Legislative framework; e) Enhancing capacity; and, f) Awareness raising.

International legal frameworks for water resources management and Pakistan's involvement

Global and regional treaties, as well as non-binding instruments from international organizations such as UNECE (United Nations Economic Commission for Europe), UNEP (United Nations Environment Programme), OECD (Organization for Economic Cooperation and Development), and the ILA (International Law Association) constitute a fledged body of rules that aims at preventing pollution of freshwater resources. In 1997, the United Nations, through the draft articles of the ILC, developed a global framework convention for global protection of freshwater resources entitled, 'The Convention on the Law of Non-Navigational Uses of International Watercourses'.[15] This convention is recognized to codify customary laws relating to water. Fifty percent of the world's river basins are shared by two or more states and provide the majority of the supply used by human activity.[16] Thus, geographical and political reasons constitute major factors in the making of international agreements relating to water. Although Pakistan is benefiting from international legal frameworks for water resources management, yet, is largely

15 United Nations Convention on the Law of Non-Navigational Uses of International Watercourses (New York, 21 May 1997, in force 17 August 2014) UNTS I-52106 (hereinafter: UN Watercourses Convention or UNWC).

16 Philippe Sands and Jacqueline Peel, with Adriana Fabra and Ruth Mackenzie, Principles of international environmental law (Cambridge University Press, 2012) 304

dependent upon the Indus Water Treaty for resolving transboundary water conflicts with India.

Transboundary water resources management and implications for Pakistan

For over 40 years, the Indus Water Treaty has proved to be an outstanding example of conflict resolution. An increase in water stress in the basin states since the early 90s has brought the Treaty under strain. In fact, its survival appears weak, although there is no exit clause. The Treaty fails to address two issues; the division of shortages in the dry years between India and Pakistan, when flows are almost half as compared to the wet years; and, the cumulative impact of storages on the flows of Chenab River into Pakistan. The Wular Barrage and Kishenganga Project on Jhelum and Neelam River present a similar problem whereby water storage during the Rabi season is critical as flows are almost one-fifth of the Kharif season. Pakistan has gone as far as calling the Treaty an inefficient forum for resolving water issues; elevating the water issue to being a "core issue"; and including it in composite dialogue, but India has refused to include water in composite dialogues because it is not ready to discard the Treaty.

Water Entitlements of India on Western Rivers and Interpretation of the Treaty

The Indus Water Treaty permitted India for creating storages on Western Rivers of 1.25, 1.60 and 0.75 MAF for general, power and flood storages, respectively, amounting to a total permissible storage of 3.6 MAF. A clear ambiguity in the Treaty occurs in its allowance to be interpreted differently, thereby creating conflicts between Pakistan and India. The Treaty also fails to clearly address India's share of shortages in relation to storage dams on the Western Rivers, an issue of major concern.

Water Scarcity and Emerging Conflicts on Apportioned Rivers

As a consequence of climate change, shrinking glaciers and altering precipitation patterns render the need to address issues of water scarcity and resources. During floods, for example, majority of the water runs into the rivers of Indus-Pakistan which leaves the province of Sindh flooded. Such negative setbacks on the economy will have eventual dire consequences if not addressed.

Impacts of Water Development in India on Flows of Western Rivers to Pakistan

With control of the Chenab river through the Salal Dam, India has several plans underway for the development of hydro-power with enhanced water storage on the Western River. Pakistan continues to face reduced flows from the Chenab owing to the recent storage of water in the Baglihar dam. Annual flows in the Chenab during wet years have continued to decline since 1958-59 with an increase in droughts since 1937-38. Same is the case for River Jhelum being controlled by India; being a major source of irrigation and hydro-power for Pakistan, it would pose dire impacts for the country if India chooses to close the gates of the Barrage. Although the Treaty limits Pakistan to prohibit construction of hydropower dams by India, it does however, grant the right to voice issues regarding the developing strategy concerning the storage of water during dry periods.

Reactive Stance of Pakistan

Awareness regarding trans boundary water issues is a recent phenomenon and systematic studies are needed. Pakistan's negligence in conducting sound analysis and delays in presenting cases to the Indus Water Commission or World Bank, have caused the issue to hang loose and remain unaddressed.

Water Use Policies in Pakistan

National Water Policy - Draft of 2015

The latest draft of the National Water Policy was circulated on the directions of the Prime Minister of Pakistan in 2015[17] and identified twenty-three action areas, each segmented further into individual targets. It provides full support in areas of water resources development using perennial and floodwater, water harvesting, water management and groundwater recharge. In addition, it also identifies the framework for water related hazards covering droughts, floods, waterlogging and salinity.

A review of the draft national water policy further indicated that it endorsed the need to adopt basin as an approach for the management of water in all environments, including the environmental integrity of hydrologic basins. Aspects related to drought management were analyzed in detail and the following policy guidelines were provided:

- Pakistan Meteorological and other Departments and Agencies shall be encouraged and supported in carrying out research work in reliably predicting droughts in short and long term perspective so that feasible counter-measures can be taken timely through modified releases from reservoirs and plan other water management strategies. Research shall aim at developing appropriate mathematical models.
- Provinces shall prepare drought management plans for different drought prone areas.
- It is recognized that small surface water carry-over storages do not provide effective relief against drought because of high evaporation losses of surface water bodies. It is therefore necessary to investigate feasibility of using ground-water aquifers as water storage facility.
- In the drought prone areas, non-water related economic activities shall be promoted and the available groundwa-ter resources be used largely for domestic and stock water purposes. In such cases, aquifer recharge facilities shall be promoted.

Balochistan IWRM policy 2006

Balochistan Integrated Water Resources Management (IWRM) Policy of 2006[18] highlighted that inefficient water use, wastage of surface water and indiscrimi-nate abstraction of groundwater resources coupled with water scarcity, have aggra-vated the current situation, thereby making management of water resources a complex and a difficult task in Balochistan. Only 36 percent of the total available water resources are utilized in an average year. The persistent drought during the period of eight years (1998-06) has resulted in negative impacts on the availability of water and livelihood of rural communities.

The IWRM approach was adopted in formulating the Policy for sixteen Policy Thrust Areas, which are essential for improving and sustaining the manage-ment of surface and groundwater resources in the province. Policy thrust areas were identified after evaluating issues related to sub-sectors of water use instead of using the traditional approach focusing only on the sources of water (surface and groundwater). This approach would also help the stakeholders to own and imple-ment the IWRM Policy pertaining to their sub-sectors of water use. Along with the IWRM approach, the water-poverty-environment framework was used as criteria, while evaluating issues and formulating policy and reforms. Basin approach is recommended for manage-ment of water in a holistic manner. For the purpose of basin level planning, framework of watershed-water-farming systems is recommended to enhance water produc-tivity and to achieve sustainability of water use. The Provincial Cabinet in its meeting on March 9th, 2006, approved all the policy thrust areas except the "Electric Tariff for Tubewells". The Fifteen policy thrust areas approved for the IWRM Policy are: a) Water availability and potential for development;

17 GOP. 2015. National water policy. Ministry of Water and Power, Government of Pakistan, Islamabad.

18 GOB. 2006. IWRM policy of Balochistan. Department of Irrigation. Government of Balochistan.

b) Water resources assessment and monitoring; c) Managing water demand; d) Linking water development with IWRM approach; e) IWRM for agriculture; f) Adjusting crops and cropping pattern with water availability; g) IWRM for other sub-sectors (non-agricultural) of water use; h) Environmental water management; i) Cost recovery of irrigation infrastructure; j) Cost effectivity of water conservation interventions; k) Promoting inter-provincial cooperation; l) Fostering participation; m) Institutional restructuring and strengthening; n) High efficiency irrigation both for surface and pressurized irrigation systems; and, o) Groundwater development and management.

Policy and reforms are outlined under each of the policy thrust areas, which are being implemented by all sub-sectors of water use. Along with policy and reforms, themes for research and feasibility studies and areas of capacity building have also been identified.

The Balochistan IWRM Policy is the only approved water policy in the country and provides a comprehensive framework which is relevant with the conditions prevailing in the province, while addressing issues of water development within the context of the basin approach, water harvesting and groundwater recharge as an integral part of watershed management, and water management through integrated management of floods and droughts to mitigate the negative impacts of these water-related disasters.

With the draft national policy lingering since the last 11 years, the best option would be that each province formulates their own water polices, which could then all be integrated into one federal water policy.

Way Forward

Increase Public Awareness

Water has been highly politicized in Pakistan and there is an extreme deficit of trust among the provinces. This deficit of trust is largely due to a lack of access to data and information. Popular papers need to be prepared along with posters and stickers for creating mass awareness. The use of mass media in creating awareness at all levels, including civil society at large, is also integral. Without awareness, water cannot be made as 'business for everyone'.

High Efficiency Irrigation Systems

Current irrigation practices are inefficient and water productivity is lowest in the Indus basin irrigated agriculture. The development of laser levelling technology and furrow-bed irrigation has resulted in saving 30 percent of water and has led to an increase in productivity by 25 percent in the district of Okara, Punjab. Such a model should be replicated in other areas as well. Likewise, the establishment of drip irrigation farming systems- a type of high value farming as a mix of creeper-type vegetables and high density orchards-in areas outside the Indus basin where water is at premium, should be adopted by farmers.

Investigation of Watershed Networks

Watershed management is essential in areas outside the Indus basin covering mountainous regions, Barani areas and Balochistan. There is a need to initiate field investigations in order to establish programmes for watershed management and link them with groundwater recharge as well as livelihood generation to encourage community participation. Integrated land use practices including plantation of forest trees, shrubs, grasses and arid fruit plants would provide surface cover and also provide fuelwood, pastures and arid fruits (mulberry, falsa, pomegranate, fig, etc.).

Updating Academic Curricula to Address Ways to Engage in Sustainable Development

The current curricula of water and agriculture institutions are largely based on books that do not have much relevance to the water and agriculture landscape of Pakistan. There is a need to revise this curriculum accordingly, and to introduce relevant courses at the Bachelors and Masters levels relating to sustainable development. Along with updating the curriculum, there is a need to develop course materials, which have relevance with the requirement of sustainable development in the country and various regions. For example, universities imparting education in water and agriculture located in each of the provinces cannot use similar curriculums when the problems are different, including keeping the climate change variabilities into account.

Development of a Central Data Repository and Website

Past efforts in creating a single central data repository have been unsuccessful owing to data collection being conducted by a mix of several agencies in the federation and provinces. The solution to this lies in first, developing a decentralized database by the different agencies, followed by centralizing this database by using this data to feed into one single central data repository. The federal statistics division would be the pertinent authority to take charge of all coordination and networking in this regard.

More Research on Water Quality

With an increase in the demand and variety of water uses, its quality is now a growing concern. Therefore, standards for water quality need to be developed for all sub-sectors of water use. There is a need to develop an inventory of water quality for surface and groundwater to represent all the major ecosystems and environments, ranging from wet mountains to the Indus basin, Barani lands, deserts and the coast. Research is needed on how to use marginal and poor quality groundwater for farming in areas where freshwater is unavailable from rainfall and surface water resources.

Finally, there is also a dearth of research on how to provide a cost-effective way of providing safe water of acceptable quality for human, livestock and freshwater fisheries. Some areas in the deserts, around the coasts, in the Indus delta, and some parts of Khyber Pakhtunkhwa, Punjab and Sindh have brackish quality groundwater, an issue that can only be addressed and rectified once there is thorough analysis to identify loopholes and develop a proper addressal framework.

Water Management In The Indus Basin: Critical Aspects

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The Indus basin has the world's largest contiguous irrigation system. Total irrigated area is 19 Mha, with 4 Mha rainfed, whereas, total cropped area is more than 23 Mha. It also has a highly transmissive and productive aquifer that augments surface supplies, and in recent years it has become a very important source of supply, particularly in the Punjab province.

The climate is tropically arid with mean annual rainfall of 238 mm and mean annual temperature at 28°C. During summers, temperatures may soar up to 45°C, causing high evaporation rates of 120 mm in the north, and 2100 mm in the south. Its high intra-and inter-annual variability makes irrigation essential for crop growth.

More than 95 percent of the annual surface water flow is appropriated for irrigation. If groundwater usage is added, then total irrigation allocations accumulate to more than the total renewable surface water. This is becoming untenable now because it leads to serious droughts, rising deficits due to increased population, urbanization, and domestic and industrial demands. Simultaneously, climate change is causing serious impacts upon demand and supply in the basin, thereby adversely affecting the prevailing water balance.

Despite the basin's massive infrastructure, the storage capacity stands limited to a maximum of 30 days of flow, and only 11 percent of the identified hydro-potential has been developed. This allows more than 30 MAF on average to flow into the sea unregulated and unutilized, thus limiting the basins capacity to provide minimum flows required for the Indus delta. Equally important is the fact that it also limits the basins capacity to regulate flood flows as a consequence of which, continued disaster in the wake of climate change, is brought upon. Unfortunately, the storage issue has evolved into becoming highly politicized, to an extent that renders no room to consider several viable options. The next best options however exist and need to be vigorously pursued to provide much needed resilience in the system.

However, increased storage capacity alone is insufficient to solve the problem. More efficient use of water needs to be targeted. The prevailing productivity per unit of water in Pakistan is among the lowest in the world. Add to this the fact, that the irrigated agriculture sector consumes more than the total annual inflows into the basin (after adding the groundwater component), it becomes evident that such a gross level of inefficiency in water usage is not sustainable in the face of rising domestic, industrial and environmental demands. Therefore, bringing efficiency in water use, particularly in the irrigated agricultural sector, is at the heart of sustainability for ensuring water, food and energy security in the country. However, this does not imply that water use in other sectors can be sidelined. Those have to be equally monitored as well, to ensure the same level of prudence in water use.

For our climatic conditions, soil types and structure, plant type and irrigation techniques are among the many factors that influence the efficiency and effectiveness of irrigation practices. It is therefore imperative to make the right decisions regarding what crops to grow, adopt appropriate irrigation scheduling, decide on the best irrigation methods, take appropriate soil enhancement measures and use all available sources of water. At the same time, decision makers have to be mindful of the fact that all of the above does not come without making the necessary investments in human and material resources.

Savings from the agriculture sector can easily meet future domestic, industrial and environmental demands provided the same level of prudence and good science is used in determining such use of precious water. There are several global examples that delineate how countries have utilized water savings obtained from the irrigated agriculture sector and invested them into meeting demands of other industries. India and China are a case in point. These countries are spending billions of dollars making water fit for human consumption and industrial activity and transporting it for its end use. Hundreds of new treatment plants and other infrastructure have been developed, along with their operating and maintenance systems. Meeting this challenge with existing technologies is already big business. For example, in China, the market for current membrane technology used for cleaning waste water is growing at more than 30 percent a year and is projected to grow at even higher rates over the coming few decades. Newer technologies offer becoming even bigger businesses.

In many advanced cities, the same sewage system collects both residential and commercial waste water, runoff rain water and snow. In the case of Singapore, for example, it collects different gradations of discharged water separately and redirects some of it to uses requiring lower levels of quality. From there, the water moves onto treatment plants and henceforth to other applications, thereby making waste water effectively utilized. Gulf States such as Abu Dhabi, also have plans underway to recycle as much as 80 percent of the water used by some of the communities. Falling energy costs are also offering support in making all of these approaches feasible.

As far as industry is concerned, the creation, adoption and availability of better measuring and monitoring tools is being developed by providers for improving water productivity. This is allowing companies to improve their water tracking mechanisms and determine where and how more efficiency can be introduced.

One of the key issues in our case is that water is not valued properly, and therefore any associated investment decisions get mired by economic distortions. Unless this issue is satisfactorily resolved, proper incentives to save water cannot be meaningfully determined and implemented. Therefore, the first and foremost requirement is the correct pricing of water.

Once this is done, several other variables in the water management equation automatically fall into place, and water management becomes more readily amenable to good scientific and economic analysis, resulting in sound policies that can get meaningfully implemented.

Another important issue is meeting the challenge of climate change. Pakistan is recognized to be a front liner among nations that are likely to be severely impacted by climate change. Since most of the manifestations of climate change are reflected in water, therefore Pakistan, being a water based economy, is high at the end of the vulnerability spectrum. Unless water management policies reflect urgency and importance, even national security may be jeopardized. Such is the grave significance of the matter for Pakistan.

The logic is simple: climate change for us is an existential threat, and the key to water security in practical terms is to improve to the best possible extent, the management of our water resources. This implies that while climate science is still evolving and the situation needs to be monitored on that end, the focus should in the meantime, be critically on water management so that the country is better prepared to absorb those shocks when they hit. That is also the same underlying philosophy that China has adopted.

The third and final point, is to assess where the country stands with respect to human resources and water management institutions. There are two aspects to this; one being educational and the other, work environment, both either strengthen or weaken institutions. Unfortunately, a great erosion of quality has taken place in both areas. Educational standards have fallen in institutions of learning and a growing apathy to absence of recognition of merit, and declining motivation in the work place has led to capacity and competence deficit. This has led to limiting our implementation capacity of development activities. This article will chiefly address engineering education in that respect.

Contemporary challenges and the tools we use to deal with them seem poles apart. Modern engineering education, good science based analysis, policies, training for best practices and research inputs are grossly lacking at each step of the way.

Suffice to say for the purposes of this discussion, it is reasonable to expect that engineers have a collective responsibility to improve the lives of people, and therefore engineering education should reflect that sense. Whether that is happening or not is still in some ways an open question, and my own view is that it is very poorly followed.

Our country continues to become more populated, more crowded, more consuming, more polluting, more connected and in many ways less tolerant than at any time in our history. It is also broadly recognized that we are altering our natural systems in various ways and various scales at all levels at an unprecedented rate. However, with endorsement and commitment towards the MDG's and the SDG's, the challenge is to be able to satisfy the needs of a population that is increasing exponentially while preserving the carrying capacity of our ecosystems and biological and cultural biodiversity, and deciding what is it that should be done now and in the near future to ensure that basic needs for water, sanitation, nutrition, health safety and meaningful work, are fulfilled for all.

These problems and the ones we will face in the near future require that the engineering profession revisit its role and adopt a new mission, one that focuses on building of a more sustainable, stable and equitable society. In the past, little attention was paid to socio-economic and environmental impacts on natural systems. The 21st century, however, requires transition to a more holistic approach to engineering. For this to happen, a paradigm shift, from controlling to working with nature, is essential. At the same time, it requires more awareness of ecosystems, ecosystem services and preservation and restoration of natural capital. Finally, it also requires a mindset of the mutual enhancement of nature and humans that embraces the principles of sustainable development, renewable resource management and appropriate technology.

Modern engineering looks at water management in a very comprehensive way. Not only does it focus on technology but places equal emphasis on socio-economic and environmental aspects, making it a balanced mechanism of an integrated process. In this way, harmony is achieved in designing water systems for development that simultaneously cater for the sustainability of water sources, its flow regimes and its ecosystems. Such integrated water resources management (IWRM) approach ensures water food and energy security, all at the same time. In our case, in doing so, national security is also strengthened because of the nature of our economy.

Finally, it is important to keep in mind that it is the single basin in which our surface and ground water and also our monsoons happen to occur. While its integrated management requires comprehensive planning, critical monitoring, prudent policy formulation and implementation and effective stakeholder participation, yet as of now, there does not exist an institution which is fully responsible for its integrity and particularly its water resources. Unless issues of water management are addressed on an urgent basis, the impending effects of climate change will unleash an economic chaos whose impacts will be far and wide.

Whether our centers of learning and work places are transitioning to the new vision, remains an open question, although it appears that we are way behind. But surely, the expectation of achieving sustainable development and management of our natural resources, particularly water resources, cannot be met unless the transition is made soon enough, because engineers in some ways hold the key to success. Maurice Strong (Secretary General of 1992, UN Conference on Environment and Development) said, ''Sustainable development will be impossible without the full input of the engineering profession."[1]

1 'Engineering Sustainable Development for the Future We Want'. Available at http://www.unescap.org/speeches/engineering-sustainable-development-future-we-want

Water Governance in Agriculture

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Water is one of the most important elements of nature that sustains life and maintains the ecological balance of our world. It is also one of the most important natural resources for any country in terms of economic, social, political and strategic perspectives. Its importance becomes more pronounced given the fact that around 800 million people suffer from chronic hunger and the world needs to produce 60 percent more food by the year 2050 to feed humanity.[1] Water is essential in agricultural productivity and against a backdrop of increasing water scarcity, food shortages in the future are a grim reality that the world needs to focus on, both in the short and long term.

Water is one of the most important components of food production systems. Without water availability and improved efficiency in allocation of water resources, sustainability of our food production systems and their potential to provide for an ever-increasing population will become a multidimensional threat for the survival of human communities. Access to water and its effective utilization has the potential of evolving into a crisis given that its per capita availability around the world continues to decline. Per capita water availability has decreased to 1,032 cubic meters in 2016 from 5260 cubic meters in 1951.[2]

At such rapidly plunging rates, water security is becoming a rapidly growing problem that needs to be tackled on an emergency basis. Food production and livestock farming have already not grown at an exemplary pace. With increasing water security issues, the threat to Pakistan's food security is real and critical. A country with more than 200 million mouths to feed and a rapidly growing population growth rate cannot survive long-term water shortages. Water security affects not only the economic sectors but also the social fabric of the society, especially in rural areas.

Being an agro based economy, Pakistan derives 22 percent of its National Gross Domestic Product (GDP) from agriculture which supports 65 percent of the rural population, directly or indirectly, and provides employment for 43 percent of the labor force.[3] The impact of water scarcity on the country's economy and primary sector employment will be devastating, eventually causing spill over effects in other sectors. A total of 54 million acres (71 percent of the total arable land) is under cultivation and 82 percent of the cultivated land is irrigated either from surface or groundwater sources.[4] Irrigation water remains the central input for sustaining and expanding the agricultural economy and dominates water use in Pakistan.

Efforts have been made in the recent past to study the issues and challenges surrounding water governance in Pakistan. Being a country that takes pride in agriculture being the backbone of the economy, it goes without saying how important water governance is for the national economy and the society itself. Water governance is a concept largely missing from Pakistan's national development and legislative narratives.

The critical aspect of water management in Pakistan is very interesting. Despite the investment (more than USD 300 billion) pumped into infrastructure development that dealt predominantly with increasing the supply of water, the demand side and the weaknesses and inefficiencies of the established water management systems in agriculture and in other sectors remains ignored. Inconsistent policies and a lack of focus on critical problems such as climate, water and ecology form the core of Pakistan's water management woes. The recent China Pakistan Economic Corridor (CPEC) initiative houses the opportunity to bring massive infrastructure development to the country and this has the possibility of affecting the agricultural sector positively. Although CPEC does not include exclusive agriculture development funds, but the trickle down effects will be immense for all sectors including agriculture. Increase in tractor production, better roads for farm to market access, exports to China or the world along with foreign investment into the sector, are main aspects of such a positive impact. In addition, the dams being constructed will provide water storage for irrigation along with cheaper electricity for farmers and a better energy supply as well. Agriculture, especially livestock farming such as poultry, has greatly been affected by power outages and high rates of energy supply. Nonetheless, it would have been very prudent on Pakistan's part if a separate chunk of CPEC would have dealt with increasing agricultural productivity in the country and strengthening the primary sector that forms the backbone of the economy.

It is also important to remember that the Sustainable Development Agenda 2030 formally adopted by the UN member states defines the Goals within which Pakistan can work to improve agriculture, water governance and food security. These include, SDG 1: End poverty in all its forms everywhere, SDG2: End hunger achieve food security and improved nutrition and promote sustainable agriculture and, SDG 6: Ensure availability and sustainable

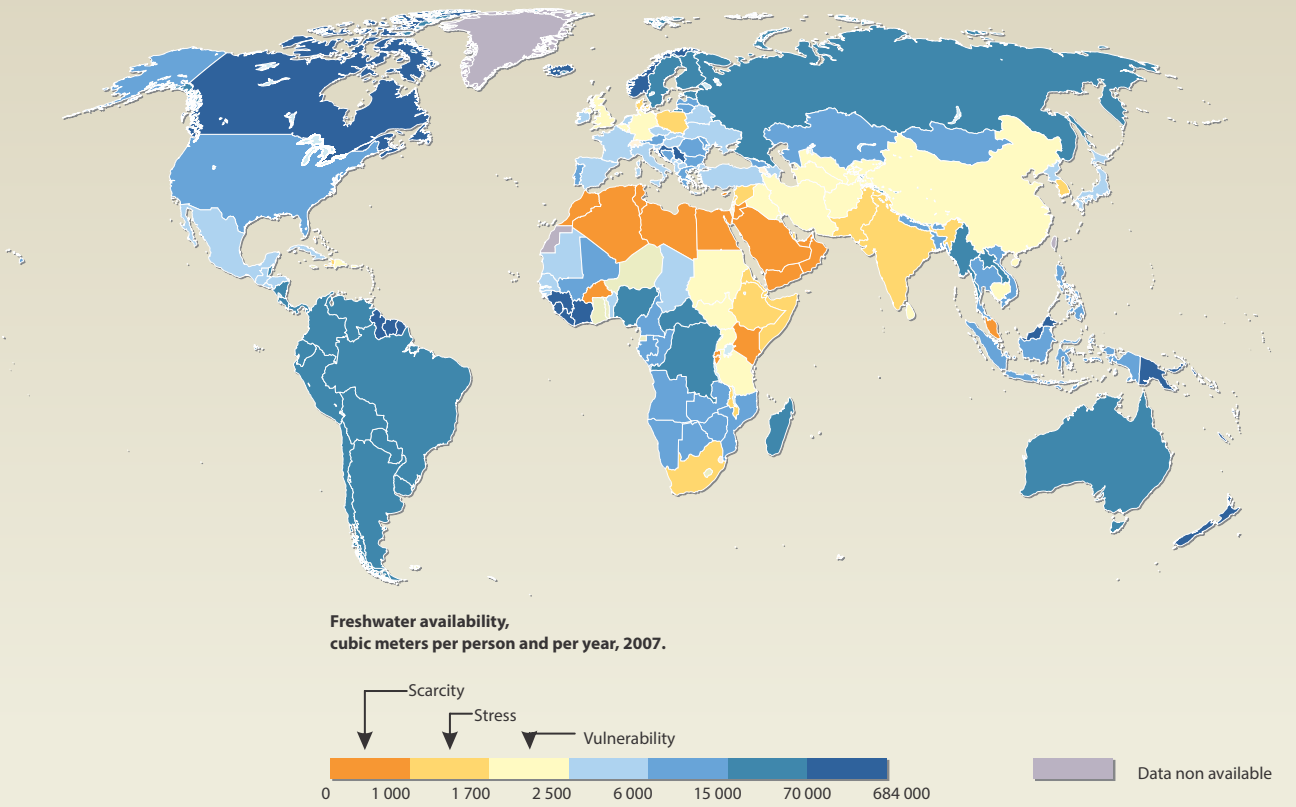
1 World Food Programme, 'Hunger Statistics'. Available at https://www.wfp.org/hunger/stats
2 Government of Pakistan, Economic Survey 2009-10, 'Chapter 2: Agriculture'. Available at http://www.finance.gov.pk/survey/chapter_10/02_Agriculture.pdf
3 Government of Pakistan, Pakistan Bureau of Statistics (2016), Labor Force Statistics. Available at http://www.pbs.gov.pk/agri-stat-tables; Agriculture Statistics Tables. Available at http://www.pbs.gov.pk/content/labour-force-statistics
4 Government of Pakistan, Pakistan Bureau of Statistics (2016), Agriculture Census Tables. Available at http://www.pbs.gov.pk/agriculture-census-tables

management of water and sanitation for all. The Goals can help define development targets, indicators, and their specific roadmaps on the way forward for the next 15 years. Through inter-sectoral communication and collaboration, government can achieve the SDGs related to agriculture and natural resources management. By adoption and aligning national and provincial planning with these SDGs, food security and water governance in Pakistan

productivity, and equity in water resources management in agriculture. The current institutional framework also faces weaknesses concerning clearly defined long-term goals expressed as water policy, non-existent incentive structure (reward and punishment) and reformed framework for stakeholders to change behaviour for achieving maximum beneficial end use of water, ambiguous application of laws and regulations, and inadequate executional

quality remains lowest on the list of water sector priority actions. The focus of governments on urban areas for development funding and mega infrastructure projects has pushed problems such as water quality into oblivion. Water mismanagement has led to dumping of minerals and waste in catchment areas, extremely low water tables and a lack of conservation mechanisms. This, along with problems such as water logging and salinity, has

Figure 1: Freshwater Availability (2007)



Source: FAO, Nations unies, World Resources Institute (WRI)

can be improved.

Water governance has been an area of investment in the past with the involvement of both donor communities and the government working to achieve this goal. An example would be when in 2013, 12 international donors came together to prepare a position paper on Pakistan's water issues. Since then, the group has held six meetings hosted by different partners. Although there appears hope, however, individual donors might continue to follow their own strategies of cooperation and conventional investment plans, but governance related interventions should be made a complementary part of larger efforts to achieve the overall objectives of secure, productive and sustainable water management in agriculture in Pakistan.

Here is a brief look at major water management issues. The water resources subsector lacks updated policy, law, regulations, rules, guidelines, and enforcement capacity for achieving efficiency,

capacity from national to local government level.

Pricing is another issue. Price of water for agriculture is extremely low; a farmer in Punjab, home to 70 percent of the agriculture production in the country, pays PKR 135 (USD 1.3) per acre, per year for canal water. Also, the reforms for farmer institutions and participation in irrigation system management, initiated in 1997 (Provincial Irrigation and Drainage Act 1997), have not delivered consistent improvements. The irrigation departments in the provinces are largely ineffective and rely on procedural rules set up by the British in the colonial era. Corruption among officials, water theft by influential landowners and a general lack of maintenance of canal infrastructure are the core reasons behind the non-delivery of the reforms.

In addition, groundwater governance and management is not a subject of interest in most investment decisions and water

rendered thousands of acres unsuitable for cultivation. Pakistan's future food security, economic stability and employment for labor is threatened due to these critical issues that are nowhere on policy makers' agendas.

These issues raise a number of questions on water governance. Let's examine some of these issues in the context of Pakistan.

Although controversial, but can we revisit the inter-provincial Water Accord and shares for agriculture? At the national level, how will we reach a decision regarding irrigation standing as a priority to make sure that Pakistan keeps producing enough food to support its population? Possibly even surplus to export to the world?

Surface water and its governance at the provincial level is also of primary concern- what is it that should be done differently in an agenda of institutional reforms and of enhancing self-reliance and the accountability of provincial stakeholders?

Governance of water sources on a micro level is also an issue that has a large impact upon agriculture. What will be helpful here, private investment or updating the Irrigation and Drainage Act (1997)? How can we protect groundwater and use it more efficiently for drinking water, and finally, what could be done to manage environment flows in a better manner?

These questions present to us an opportunity. If an agreement can be reached on answers to these questions, the solutions will become clearer. The solutions can be wide ranging and far reaching. They can include Public Private Partnerships, Government run projects, public infrastructure development schemes, NGO's, donors as well as the citizens. A greener and ecologically friendly narrative in terms of water policy needs to be peddled among the population so that wastewater from industries, homes and cities is treated properly before being reused for irrigation or being put back into the water bodies. Moreover, awareness of new technologies, water conservation and protection of water sources is equally important in ensuring Pakistan attains water security in the near future.

Donor groups also need to play their role more effectively: an example could be by collectively recognizing and articulating a coherent case for parallel development of infrastructure and governance and investing in both aspects so that water can be controlled, delivered, and used for maximum sustainable benefit to society. Mixed and contradictory messages should be avoided. A higher priority should be given to the formulation and implementation of problem-oriented water policies and strategies. This can be achieved by providing technical and financial support and by setting timelines to achieve policy objectives that are tied to investment decisions. Moreover, they can support public and private service providers to adapt to their institutional capacities and ensure delivery of sustainable services to water users. The government and donors should work together in exploring private sector investments in canal irrigation systems management.

The task of improving governance and management of water resources to help Pakistan's agricultural sector and food security needs, might appear daunting but as they say where there is a will, there is a way. It is just that solutions require a paradigm shift in water resource development and management strategies for sustainable agriculture in Pakistan.

Mainstreaming Women in the Water Sector: Old Challenges, Possible Solutions

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In his monumental book called the 'Revenge of Geography', Robert Kaplan says that a good place to understand the present, and to ask questions about the future, is on the ground, traveling as slowly as possible.[1] And when we travel slowly through Pakistan from the mountains of the north, through the Indus basin and on to the coastlines in the South, we see the gender gap in all its manifestations. And nowhere is it so stark as in Pakistan's resource base and its main economic assets-land and water. Integrating a gender sensitive approach to development and conservation of water requires an understanding of the link between gender equality and sustainable water management. However, it needs to be stated at the outset, that Pakistan's main regular demographic, economic, development and human development surveys and reports do not carry data on water and related areas disaggregated by gender to allow a trend analysis. The latest report of the Social Policy and Development Centre (SPDC) published in 2016 has some information on urban water but it is not disaggregated by gender .[2]

Pakistan ranks 147 on the Gender Development Index (GDI), and 121 on the Gender Inequality Index (GII)[3], while its Gender Empowerment Measure (GEM) is only 0.377.[4] According to the 19th Annual Human Development in South Asia Report 2016, the region ranks in the bottom with respect to the female human development index in the world, only better than Sub-Saharan Africa.[5]

In the Global Gender Gap Report 2016 produced by the World Economic Forum [6], Pakistan ranked 143 out of 144 countries, down from 112 in 2006. While it ranked much better in terms of political and economic participation, Pakistan's gender gap is significant and alarming, reflecting the low status of women in Pakistan's agriculture-based economy-an economy heavily dependent on water. There are no regular and periodic gender disaggregated regular reports on the use of water, sanitation, irrigation and related areas.

The situation in terms of rights and access to water and sanitation, is nothing better. Although the number of households with access to an improved water source has remained more or less the same over the past 15 years, the percentage of households with access to piped water or tap water has reduced over time. The percentage of households with access to tap water fell from 34 percent in 2005 to 32 percent in 2010, and to a further 27 percent by 2015. Sanitation facilities also show a similar picture, where the percentage of households with a flush toilet has increased from 52 percent to 73 percent between 2005 and 2015, but the proportion of households that have a flushing toilet connected to a piped sewerage system is still less than one quarter.[7]

Global Gender Issues in Water and Where Pakistan Stands

Globally, men have a single role in society-the productive role or earning an income. Women on the other hand, have the burden of four roles -productive, reproductive, societal linkages and care giving. They are very often tied to homes because of their multiple roles, so that their presence in the water sector is seen as being 'domestic'-carrying and storing water for home consumption, cleaning toilets, doing kitchen gardening etc.

A number of surveys carried out in the decade of 2000 carried data on the number of hours women spent in fetching water, however, this kind of data collection has not been repeated since. These surveys confirmed that rural women, especially in 'water stressed' communities, spend a high proportion of their time collecting water. The Pakistani Rural Household Survey of 2001 found that 25 percent of women reported fetching water during the week prior to the survey; and, in water stressed communities, the percentage of women spending time collecting water increased significantly to up to 60 percent in rural Baluchistan and 40 percent in rural Sindh. Research shows that when access to drinking water services worsen, women, not men, bear the higher time costs and according to one study, households in

1 Kaplan R D, The Revenge of Geography, Random House, 2012, pp xiii.
2 Social Development in Pakistan, Annual Review 2014-15: The State of Social Development In Urban Pakistan, SPDC, 2016.
3 Human Development Report 2015, UNDP 2015, http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/PAK.pdf
4 http://www.rrojasdatabank.info/hdr20072008tab29.pdf
5 http://epaper.dawn.com/DetailNews.php?StoryText=22_11_2016_002_003
6 Global Gender Gap Report, World Economic Forum, 2016, pp 284-285.
7 Pakistan Development Update-Making growth matter, The World Bank-IBRD.IDA, Nov 2016.

some rural communities could save as much as 1,200 hours per year if water was available within the home. Difficult access to water increases women's work load and reduces time that could be allocated to other productive activities. In particular, in Pakistan, putting water sources closer to home has been associated with increased time allocated by women for market work.[8]

Another World Bank study (which used primary data collected especially for the study) delineated that if a once daily frequency is assumed for women carrying water, it would mean that more than 200 hours a year were being spent in fetching water. The figures for one village under study showed 1.73 hours spent in carrying water twice a day, totaling to a yearly water collection time of 1,260 hours. If time spent in waiting and filling water containers was also added, that would mean a further 300-400 hours per year. If looked in a nutshell, between 380-630 hours and up till 30-50 tonnes of water carrying effort was an approximate number for the majority of villages. The study clearly illustrated that this load fell predominantly on women members of the households.[9]

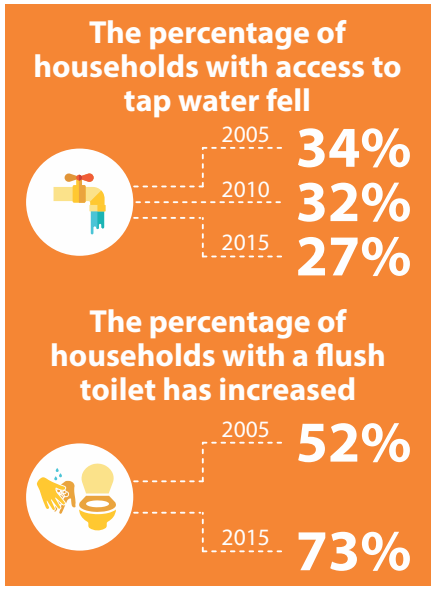
Many development sector programs refer to women as beneficiaries of water related interventions, as half or close to half. For example, the Pakistan Poverty Alleviation Fund (PPAF) estimates that of the 14.7 million people availing its infrastructure and water projects, 49 percent are women.[10] Yet, the amount of women being actively engaged in the water sphere, be it through participating in the workforce or voicing out concerns, stands as a stark reality. However, recent years have witnessed an increase of women in water advocacy, water NGOs, media and among water practitioners.[11]

The toil of women, whether at home, at work or in public is not seen a 'work', if non-remunerated. Women form an overwhelming part of the world's non-remunerated labor force, especially in agriculture, but own a tiny part of the world's agricultural lands. Lack of property rights and tenure insecurity renders women farmers powerless. This is especially true of Pakistan, where land ownership is also a requirement for right to water.

Women have unequal rights, in some cases their human rights are severely violated. Pakistani women face discrimination and violence across the board.[12] There are huge constraints on women participating in collective action groups. Their incomes and profits are expropriated by the 'system' or by the men of their families. This state of affairs affects how women can engage with water sectors, especially agriculture and food production.

A large portion of the world's food output originates in the hands of women farmers and women provide over half the agricultural workforce (if we add home farming as well). Homestead production, backyard production and kitchen gardening etc, contributes to household food security by providing direct access to food that can be harvested, prepared and consumed within living space. Women in Pakistan are not only careful users of water but also the custodians of this knowledge and practice.

Women in Pakistan also face discrimination in the way their labor is viewed and recorded. 74 percent of women in rural areas are economically active, yet only seven percent of women workers working 50 hours and more are recorded as 'full-time'. A full-time worker is defined as one who does only agricultural work and thus, most women fall into the part-time category as they do household work also. Therefore, there are probably more full-time women agricultural workers than suggested by a recent survey on employment trends.[13]



In Pakistan, women in rural areas do 4.9 hours of unpaid care and domestic work per day, compared to only 0.5 hours for men. Only two out of every ten working age women are in the labor force, compared to seven out of every ten men, and three out of every four female workers are employed in the agriculture sector.[14]

Women's Status in Pakistan and their Rights and Roles in Water Sectors

The Constitution of Pakistan (1973), Article 25 states as follows:

- All citizens are equal before law and are entitled to protection of law
- There shall be no discrimination on the basis of sex alone
- Nothing in this Article shall prevent the State from making any special provision for the protection of women and children

In spite of this, Pakistani women face many gender inequalities which often determine their access to water and their participation in water related debates, policy, programmes and community-based initiatives. Many contradictions remain.

While 19.7 percent of parliamentary seats are held by women, only 19.3 percent of adult women have reached at least a secondary level of education compared to 46.1 percent of men. For every 100,000 live births, 170 women die from pregnancy related causes and the adolescent birth rate is 27.3 births per 1,000 women of ages 15-19. Women's participation in the labor market is 24.6 percent compared to 82.9 for men.[15]

Because of the dominant view in Pakistan that women's role in the water sector has to do largely with domestic water, the core issues of ownership and control access are seldom in the forefront of research or planning. The area of 'water rights' is very blurred in Pakistani law, and land ownership is usually a proxy for access to, or, entitlement to water. This means that other than water for drinking, sanitation and domestic needs, the only way to have water entitlement, is by owing land.

In the recent report of the World Economic Forum on the Global Gender Gap 2016 [16], Pakistan scored worst in terms of access to land use, control and ownership. Moreover, the Pakistan Demographic and Health Survey 2012-13 depicted that a higher proportion of men than women in Pakistan own land. Only four percent of women own land either alone or jointly, as compared with 31 percent of men.[17] Given the interplay of formal and customary laws in inheritance to the disadvantages of women, they have perfunctory ownership in a majority of cases with little control to buy or sell .[18]

8 Pakistan Rural Household Survey 2001, World Bank.
9 Kamal S, Women and Water: Issues of Entitlement, Access and Equality, World Bank, 2005.
10 PPAF, Brochure Women at the Heart of our Work – why inclusion matters, 2016.
11 For a review of women in the water sector, see Situational Analysis of Women Water Professionals in South Asia, SaciWaters, India, August 2009.
12 See Annual Report on Violence Against Women in Pakistan, Aurat Foundation, 2014.
13 Pakistan Employment Trends, Pakistan Bureau of Statistics Division Ministry of Economic Affairs and Statistics Government of Pakistan, 2011.
14 Human Development in South Asia 2016: Empowering Women in South Asia, HDC and Mahbub ul Haq Research center, LUMS.
15 Human Development Report 2015, UNDP 2015, http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/PAK.pdf
16 Global Gender Gap Report, World Economic Forum, 2016, pp 284-285
17 Pakistan Demographic and Health Survey, USAID, National Institute of Population Studies (NIPS), Islamabad Pakistan, 2012-13.
18 Kamal S, Use of Water for Agriculture in Pakistan: Experiences and Challenges presented at conference on The Future of Water for Food, Lincoln, Nebraska, USA, 2009.

In 2011, a study from Aurat Foundation's USAID-funded Gender Equity Program (GEP) found that while Pakistan's agricultural policies appear to encourage the inclusion of women in the sector, they do not recognize them as registered farmers. According to a land tenure and property rights profile on Pakistan, "In general, there is little acceptance under customary and religious law for women's ability to control and manage land".[19] The country's agricultural policies promote cash crop farming for export, with support to farmers who hold more than five acres of land. Because the majority of Pakistani women fall outside of this category, they are not recognized or registered as farmers. In addition, the agricultural census does not consider women as full-time agricultural workers, because they also work at home.[20] This means that all the work of women in growing food in and around their homes is not recognized as 'agriculture' and therefore neither remunerated nor valued.

The Tenth Five Year Perspective Plan (2010-15) speaks of a focus on women under rural development strategies.[21] It states special emphasis accorded to women as playing a vital role in agriculture, and of incentives to be provided to women (i.e. provision of land for landless, soft loans for purchase of equipment, seeds, fertilizer etc).[22] However, there has yet to be an assessment to see if these incentives were ever provided and what the results were.

A review of research studies on water in Pakistan has shown that very few actually attempt a gender analysis or speak of gender impacts. Gender-disaggregated data is very rarely available or is very rudimentary, if available. The regular demographic and statistical reports have little reference to the water sector in depth, or refer only to drinking water and sanitation (but not disaggregated by gender).[23]

Women's Entitlement and Access to Water

The poor in Pakistan are concentrated in environmentally fragile ecological zones, where they face floods, droughts and different kinds of environmental degradation, including polluted water bodies and fast-depleting water sources. Some serious analytical work has been done on the idea of 'entitlements', and the linkages between poverty and environment, including water. This work shows clearly how women are consistently more disadvantaged than men, when it comes to claiming entitlements to water. For example, women's use of common property resources has been crucial in maintaining household water and food security, but gender disparities distort access to land and water. Existing social and cultural biases, inequitable inheritance laws and the inadequacies of legal structures further limit ownership and control by women.

While water is crucial to Pakistan, the nexus of women and water is largely seen in terms of romantic depiction and some attempts have been made at addressing women's practical needs through domestic water management and small scale water projects. They remain largely invisible in water institutions, water policies, strategies, programs and conservation initiatives. As Pakistan faces a bleak future in terms of water availability, high population growth rates and the depletion and pollution of its water bodies and systems, women are generally not recognized as an especially vulnerable group in terms of impacts, nor as a legitimate group to engage in the efforts to ward off the impending water-related crises. They are not recognized as a party to the current debate in the country on dams, water infrastructure, water distribution, irrigation, agriculture and competing demands for use of water. Given that the water sector is considered outside the purview of women as such, there are few women in Pakistan who have become prominent in this area as visionaries, scientists, planners, managers, technicians, researchers and professionals.

Women water engineers and water professionals face the 'glass ceiling', beyond which, their careers and professional advancement opportunities are closed to them. The 'feminization of poverty' is a reality in Pakistan and visible in both urban and rural areas.

Given that in Pakistan land ownership is a proxy for water rights; and few women own agricultural lands, they have limited say in how water is distributed. So the benefits of irrigation infrastructure and rehabilitation, funded by the government, have directly enriched male landowners. Land values have increased about 30 percent in the past decade and these male landowners are likely to continue to receive the lion's share of the benefits of low water charges and infrastructure improvement.[24]

In spite of these difficulties, there have been some good practices and examples in Pakistan. Some NGOs believe that women are key to improving water management and have developed Women and Water Networks across Pakistan, as well as other programs to support women farmers and home-based agriculture.[25] Rural support and poverty alleviation programs have ensured women's participation as beneficiaries and active partners in water-related infrastructure development.[26]

Conclusions and Way Forward

The importance of empowering women across the board and mainstreaming women in the management and governance of water, has been recognized at the global level since the 1980s. Pakistan is a signatory to the relevant declarations and commitments. The global commitments covering water do not specifically address the issues of equitable division of power, work, access to, or ownership of, environmental entitlements (including water) between men and women. Combining the gender equity and equality commitments with water-related goals can, however, give a solid boost to gender mainstreaming in the water sector in Pakistan and ensure that the specific needs and concerns of, and impact on, men and women from different social and economic groups, are identified and addressed. The new Sustainable Development Goals have the potential to combine and build synergies to put women squarely in the middle of water development, conservation and management.

While there is no one-size-fits-all solution, the emerging technologies and credit lines in the water sector can be made more suitable to women's needs and emerging agricultural value chains can break down traditional gender divisions of labor. We can design interventions in water supply, irrigation, agriculture and municipal sectors that explicitly target women and get the 'buy-in' of men in these interventions, so they do not block the advancement of women. There is need to promote collective action among women and cultivate women's orientation to income, rather than subsistence only, that is, to move from kitchen gardening to productive agriculture-and protect women's control over their economic gains. Such a shift will require the recruitment and training of more women as service providers, professionals and experts.

And finally, Pakistan must accept explicitly that it must invest in women as drivers of water management and conservation, agricultural growth and food security.

19 USAID. 2010. USAID Country Profile: Property Rights & Resource Governance. Pakistan. Available at http://usaidlandtenure.net/sites/default/files/country-profiles/full-reports/USAID Land Tenure Pakistan Profile 0.pdf (page 8)

20 Ibid. Page 10.

21 The Tenth Five Year Perspective Plan-Investing in People, 2010-15, Planning Commission GoP, Islamabad, pp 87.

22 Ibid, pp 89.

23 For example, the Pakistan Labour Survey, Pakistan Economic Survey, Household Integrated Economic Survey and Agricultural Census.

24 Kamal S, Use of Water for Agriculture in Pakistan: Experiences and Challenges presented at conference on The Future of Water for Food, Lincoln, Nebraska, USA, 2009.

25 Proceedings of the International Water Conference on Securing Sustainable Water for All 2015, organized by Hisaar Foundation, 17th and 18th November 2015.

26 These include Pakistan Poverty Alleviation Fund, national and provincial rural support programs.

Impacts of Climate Change on Water Resources of Pakistan

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Global Scenario

It has been scientifically proven that climate change is affecting every country in the world, impacting both natural and man-made systems.[1] Climate change indicators have accelerated the melting of polar ice shields resulting in a gradual rise in sea levels. Some regions are facing extreme weather events such as unprecedented rainfalls, while others are experiencing heat waves and droughts. The current changing climate scenario presents a high risk to the achievement of water and food security. This is especially true for developing countries, who, owing to their limited adaptive capacities, are more vulnerable to the risks posed by climate change. According to UNDP, an annual investment of USD six billion is required for disaster risk management of natural disasters such as flooding, tsunamis and earthquakes.[2] With the worldwide adoption of the Sustainable Development Goals (SDGs), whereby Goal 13 deals specifically with taking action to combat the impact of climate change, new targets appear to be developed including ensuring that developing countries receive an annual allocation of USD 100 billion until 2020 in order to aid them in mitigating the impacts of climate change.[3]

It has been documented that climate change has direct impacts on the drivers of the economy including agricultural outputs and worker productivity. In a recent scientific study, researchers found that by the year 2100, unmitigated climate change could reduce the global Gross Domestic Product (GDP) by 23 percent.[4] For South East Asia, where the economies rely heavily on agriculture and natural resources, the impact of global warming is expected to be worse.[5] Climate change, therefore, would be a very serious challenge hindering sustainable development and poverty eradication goals in the region. Mitigation measures for climate change are imperative to achieve various SDGs including those for sustainable economic growth, poverty and inequality.

The global temperature is projected to continue rising dramatically if no policy interventions are made to limit the Global Greenhouse Gas (GHG) emissions. With rising temperatures, resulting in accelerated glacier melting and consequently increase in sea levels and the frequency of floods, millions of people are put at risk, particularly those residing in coastal and low-lying areas. Although melting glaciers has been an occurrence since the end of the ice age, however, the past few decades have witnessed an increase in the melting of these fresh water reservoirs-70 percent of the world's freshwater is frozen in glaciers-at rates that cannot be explained by historical data.[6] Empirical simulations project that a temperature rise of 4°C has the capacity to eliminate the entire world's glacier mass. Even the least damaging scenario whereby the temperature increase is at 1°C accompanied by increase in rainfall and snow, glaciers would continue to retreat over the 21st century. The Hindu Kush-Karakoram-Himalaya (HKH) glaciers are particularly vulnerable to climate change indicators. This ice-bound water may result in the danger of Glacial Lake Outburst Floods (GLOF) and cause unpredictable inflows to rivers supporting one third of the world's population in the downstream. Resulting from increased glacial melts, sea level is projected to increase at 0.2-0.4 mm annually during the current century thereby mounting a challenge of erosion, salt water intrusion in to fresh water aquifers and compromised water security for millions of people, as well as biodiversity in the coastal habitats.

National Scenario

According to the Global Climate Risk Index (2016) Pakistan ranks 8th (high risk) in terms of its vulnerability to climate change.[7] This vulnerability to climate risks has amply been demonstrated in recent years by severe drought (1999-2002), and floods, including the very devastating one in 2010 which affected 20 percent of Pakistan's population.[8] The country's economic structure is predominantly dependent upon the agricultural sector, which contributes approximately 22 percent of the national GDP along with being an important source of livelihood to 67 percent of the rural population. Climatic parameters like increase in temperature, rainfall intensification, frequent episodes of drought and floods, and heat and cool waves etc. all render the agro-based economy of Pakistan more vulnerable.

Climate change is expected to amplify

1 Intergovernmental Panel on Climate Change. (2014). Climate Change 2014–Impacts, Adaptation and Vulnerability: Regional Aspects. Cambridge University Press.

2 UNDP, Sustainable Development Goals: Goal 13 Climate Action. Available at: http://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-13-climate-action.html

3 UN. (2015), Goal 13: Take urgent action to combat climate change and its impacts. Available at: http://www.un.org/sustainabledevelopment/climate-change-2/

4 Hsiang, S. M., Burke, M. & Miguel, E. Global non-linear effect of temperature on economic production. Nature 527, 15725 (2015).

5 IPCC, 2014: Summary for policymakers in Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

6 World Wide fund for Nature (WWF), Climate Change: Glaciers. Available at WWF.panda.org/climate change/glaciers

7 Kreft S., Eckstein D., Dorsch L. & Fischer L., Global Climate Risk Index (2016). German watch, Munich ReNatCatService. Available at https://germanwatch.org/en/download/13503.pdf04

8 Global Facility for Disaster Reduction and Recovery, Annual Report 2011: Building Resilience to Disasters-Delivering Results. Available at

water stresses in Pakistan. A growing threat of GLOF, increased glacier melting because of rising temperatures, seawater intrusion, intense and unpredictable rainfall and changes in monsoon are just some of the ways in which climate change is expected to affect Pakistan's hydrologic resources. Any climate change triggered events accelerating/decelerating the snow and ice melts in the Hindu Kush-Karakoram-Himalaya (HKH) mountains have the potential to cause serious repercussions on water flows in the Indus Basin. This would ultimately have implications for all sectors of economy especially agriculture, given that 90 percent of the total agricultural produce depends on the Indus Basin Irrigation System.[9] Along with these risks, managing ground water resources continues to be a major challenge in the Indus Basin. The monsoon season, especially, swells up waterlogging and salinity when tube wells tap in to brackish ground water. These risks amplify an already problematic situation given that Pakistan is amongst the most water-stressed nations in the world. Per capita access to surface and groundwater sources is expected to continue to decline in the decades ahead, driven largely by demographic changes and urbanization. The potential for climate change to jeopardize the country's efforts to increase its water, energy and food security has been acknowledged by the Government of Pakistan.[10]

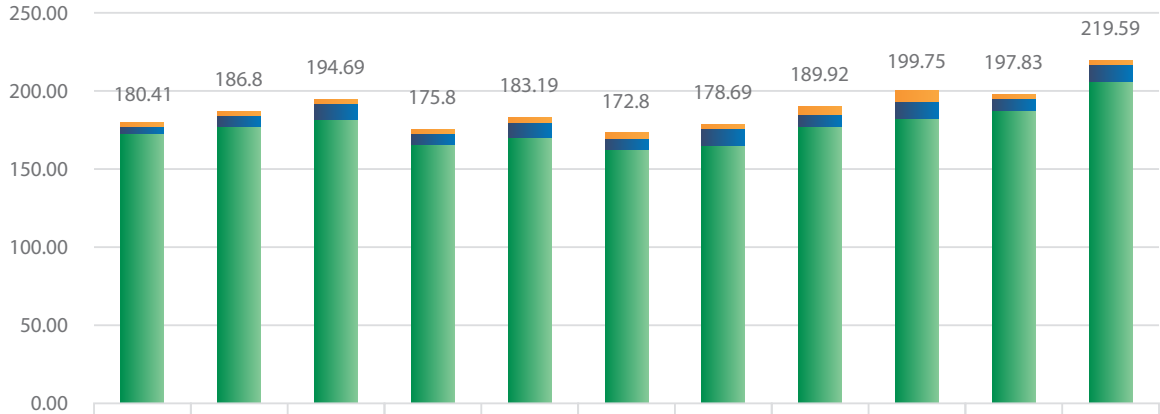
Projected Changes in the Climate and Indus Basin

The Indus Basin receives its water flows from rainfall, snow and glacier melting. Changes in the climatological parameters will have an impact on the distribution and timing of precipitation (rainfall and snowfall) and on the melting of snow and ice. The impact of climatic changes in the period leading up to the year 2050 is more likely to be reflected in changes in the timing of peak flows and increased variability in flow levels, primarily due to greater unpredictability in the rainfall (monsoon) regime. Precipitation levels in the Indus Basin will increase during the summer period (June to August) over its upper, central-eastern and southern regions[11] and hence the flows. Certain regions over the Indus Basin have a predicted increase of 10-25 percent precipitation between 2021 and 2050, compared with the baseline period of 1961 to 1990. Temperatures in the Indus Basin will continue to rise in the coming decades- in both summer and winter-and there is a possibility of an increase in mean annual precipitation in the Upper Indus Basin and a decline in the lower portion of the Basin.

Glaciers respond quickly to changes in their surrounding climate by gaining or losing mass in the form of snow and ice, and hence, are extremely susceptible to climatic variations.[12] According to empirical evidences, glaciers of the HKH region are rapidly losing mass and strongly retreating. However, several studies in recent years have also reported the 'Karakoram anomaly'[13] of expanding or neutral glaciers in the Karakoram region. Such paradoxical trends within the same glacial region support the hypothesis that changes are more likely to be controlled by local dynamics than by regional or global trends.[14]

Influenced by climate change indicators, accelerated glacier melting resulting in sea level rise is a major threat to coastal habitats and mangrove forest ecosystems globally. According to the Intergovernmental Panel on Climate Change (IPCC, 2013), frequency and severity of extreme weather events have been predicted to surge globally. Prolonged flooding and intrusion of sea water may cause plant death or alter species composition thus hindering mangroves productivity. As per recent

Figure 1: Water demand scenarios in Pakistan



	2015	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Industry	2.30	2.65	2.73	2.65	2.73	2.65	2.73	4.70	5.80	2.65	2.73
Municipalities	5.11	7.15	9.96	7.15	9.96	7.15	9.96	8.22	11.45	7.58	10.66
Agriculture	173.00	177.00	182.00	166.00	170.50	163.00	166.000	177.00	182.50	187.60	206.20
Total	180.41	186.8	194.69	175.8	183.19	172.8	178.69	189.92	199.75	197.83	219.59

9 Qureshi, A. S. (2011). Water management in the Indus basin in Pakistan: Challenges and opportunities. Mountain Research and Development, 31(3), 252–260.

10 Government of Pakistan (2012). National Climate Change Policy. Islamabad: Ministry of Climate Change.

11 Shrestha et al. (2015). The Himalayan Climate and Water Atlas: Impact of Climate change on water resources in five of Asia's major river Basins. ICIMOD, GRID-Arendal and CICERO, Kathmandu, Nepal.

12 Ibid

13 The Karakoram anomaly refers to the observation that glaciers in the Karakoram Mountain range have either remained stable or even increased in size in contrast to glaciers in the Hindu Kush and Himalayan mountain ranges, as well as other glaciers worldwide, which have receded in recent decades due to climate change.

14 Singh et al. (2011). Climate change in the Hindu Kush-Himalayas: the state of current knowledge. International Centre for Integrated Mountain Development (ICIMOD).

recorded increases of 3.2 mm/year in sea level, coastal flooding appears a major possibility with sea level projections showing a rise by 0.98 mm by the year 2100.[15] Frequency of Atlantic hurricanes may double up, as a direct result of human induced climate change triggered extreme La Niña events [16], however, storm formation and length would be spatially variable. Mangrove position in relation to storm track and wind velocity would play a critical role in determining the vulnerability of these Rhizophora.[17] Rainfall patterns and rising temperatures, among other climate change indicators, would influence mangrove distribution, extent, growth rate, species composition, phenology and productivity.[18] In Pakistan, the mangroves loss is momentous, where expanding erosion and sea water trespassing has resulted in the extinction of numerous mangrove species. Due to a rise in sea levels, erosion is approximately 61 meters/year [19] totaling a loss of 0.1 million hectares of fertile land to erosion, coupled with approximately 75 percent of a loss of Pakistan's mangroves in the last three decades. The erosion and intrusion continue to escalate with every mm rise in sea level, shrinking mangrove ecosystems and exposing the country and coastal areas to tropical cyclones like Yemyin (2007) and Phet (2010).

Climate change is projected to intensify the risks to already vulnerable coastal communities globally. This is true especially for developing countries who possess limited resilience and adaptive capacities to coastal floods. By 2030, an approximate 46 percent of the global population will be abiding within a 100 km radius from the coast, almost twice the present distance. Currently, coastal flooding impacts a population of nearly 10 million, a figure expected to rise up to 50 million by the end of the 21st century. Consequently, coastal communities will also be victim to various socio-economic ramifications including land loss, outbursts of marine-related infectious diseases, infrastructure and loss of biodiversity rich coastal habitats. Although different regions will encounter different level of impacts, however, the economic vulnerability of delta cities is imminent under the current scenarios of climate change.

The impacts of climate change on water sources will have consequences for other sectors as well, including agriculture, energy production and public health. For instance, the likely consequences on agriculture could be less water availability, shifts in cropping patterns and crop rotations accompanied by significant yield reductions of Pakistan's main cash crops-wheat, rice, sugarcane, cotton and maize. Pakistan's expanding thermal power production is highly dependent on water and sensitive to temperature increases. Projected increases in air temperatures may affect thermal power plants by decreasing the efficiency of the thermal conversion process, resulting in a loss of production or electrical output.[20] Similarly, for gas turbines, a rise of 5.5°C in ambient air temperature may reduce output by approximately three to four percent.[21] Such conditions may fuel the competition for increased water resources in order to meet the growing needs of these installations. Hydroelectric power installations may also be affected by greater variability in water flows. A greater risk of negative health outcomes due to poor water quality is also a likely outcome, as the increase in heavy rainfall events, floods and droughts is directly proportional to the increase in climatic variations.

Increased Water Demand Influenced by Climate Change

Climate change, inefficient use of water for irrigation, and resultantly, groundwater overexploitation limits the country's water security. During the last two decades, demand has increased by eight percent for cropping only. Whilst the supply might not have serious impacts, however, the demand will increase significantly under different scenarios (Figure 1). Climatic variations may increase cumulative water demand by up to 13 percent by 2050, for all economic sectors. These increases in water demand are triggered by higher temperatures particularly in the plain areas of the country. The immediate threat posed by climate change to Pakistan's water sector therefore, is on the demand side rather than availability. Any change in water flows or ever increasing demand of water triggered by climate change could have serious repercussions on the country's economy. Per capita economic growth is already at low to medium scale and its sustainability would be hard to achieve unless serious attempts are made. As far as hydropower production is concerned, given that changes in water flow patterns in the Indus River Basin will not necessarily result in any implications for large hydro projects, a projected change in peak run-off and increasing temperatures could lead to conflicting water demands between different users. It is therefore imperative that the resulting growing trade-offs between other water users and energy generation are considered and changes in water allocation rules are carefully assessed.

Described as climate change 'hot-spots', the river basins of South Asia experience regular occurrences of extreme weather events, which are projected to occur more frequently and with greater magnitude expected to cause dire economic, social and environmental consequences. The National Climate Change policy has failed to address the implications of climate change on critical sectors such as water, and issues like widening gaps between the supply and demand of water. It is imperative to integrate such climate change measures whilst planning national strategies and policies, so as to have preparedness measures for climate related calamities. Capacity building for mitigation and adaptation in climate changes, awareness raising and technological advancements for early warning systems and impact reductions would simply be a dream without giving thoughtful considerations to climate change at policy and research levels. Unfortunately, all these repercussions would jeopardize the country's ability to attain the sustainable per capita economic growth and meet the target of minimum seven percent GDP annual growth by 2030, as defined under the SDGs.

Thus, there is a growing need to increase capacity in Pakistan to anticipate and minimize the impact of climate change on water resources by:

- Deepening knowledge and action on water demand and ways in which to promote more efficient water use;
- Strengthening research capacity in climate change adaptation; and,
- Taking concrete measures to incorporate these adaptation mechanisms at the policy level, a notion currently being suggested as the main impetus behind the country's future line of action in the water sector.

An amalgamation of multiple elements including technical advancements and social considerations is required in order to combat the far reaching impacts of climate

15 Church, J.A., P.U. Clark, A. Cazenave, J.M. Gregory, S. Jevrejeva, A. Levermann, M.A. Merrifield, G.A. Milne, R.S. Nerem, P.D. Nunn, A.J. Payne, W.T. Pfeffer, D. Stammer and A.S. Unnikrishnan, 2013: Sea Level Change. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

16 Cai et al. (2015). Increasing frequency of extreme El Niño events due to greenhouse warming. Nature Climate Change 4:111–116.

17 Rhizophora is a genus of tropical mangrove trees, sometimes collectively called true mangroves.

18 Gilman et al. (2008). Threats to mangroves from climate change and adaptation options: a review. Aquatic Botany 89:237–250.

19 Ibid.

20 Makky, M. and Kalash, H. (2013). Potential Risks of Climate Change on Thermal Power Plants. Available at https://www.researchgate.net/publication/236174007

21 Asian Development Bank (ADB). (2012). Climate Risk and Adaptation in the Electric Power Sector. Available at http://www19.iadb.org/intal/intalcdi/PE/2012/12152.pdf

change. First, an integrated water resources management approach encompassing both surface and ground water, is the need of the hour. Second, thorough studies at provincial levels incorporating vulnerability assessments, need to be carried out to fully understand how climate change will affect their water resources and the associated socioeconomic consequences of these changes, as well as identify priority climate risk management strategies. Third, fostering the development of a climate change community of practice in Pakistan is highly recommended.

Moreover, a coherent national water policy with due consideration to climate change should be finalized at the earliest. Only integrated planning is not sufficient and the planning trajectory of top-down while neglecting local concerns, has often yielded non-satisfactory results in the past. Now is the time to strategically connect local NGOs and national action plans, with neighboring NGOs and governments.

Last but not the least, Pakistan's climate change and water policy needs to strengthen climate change education at the post-secondary level to build capacity to undertake research and action to reduce vulnerability to climate change impacts, accompanied by an increasing role of government in the promotion of water demand reduction strategies. Finally, increased focus on the implications of growing water demand and the impacts of climate change in energy planning is of paramount importance.

Water, Sanitation and Hygiene (WaSH): A case study on Pakistan

Mian Muhammad Junaid

Manager Basic Services
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Current Situation

Water related issues

Pakistan is culturally and linguistically diverse, with an equally varied set of political viewpoints and cultural mores. The country depends heavily on annual glacier melts and monsoon rains. Water from these sources flows down the rivers and out to the sea. En route, there are seepages into the ground, where water-bearing rocks or aquifers absorb and store this water. Most parts of the country receive scarce rainfall and have little or no access to surface water. According to a report published by the Asian Development Bank, the country's storage capacity is limited to a 30 day supply currently, which is well below the recommended 1,000 days for countries with a similar climate scenario as Pakistan. Water pollution is one of the major threats to public health in Pakistan. Drinking water quality is poorly managed and monitored. Drinking water sources, both surface and groundwater, are contaminated with coliforms, toxic metals and pesticides throughout the country. Various drinking water quality parameters set by the World Health Organization (WHO) are frequently violated. Human activities like improper disposal of municipal and industrial effluents and indiscriminate applications of agrochemicals in agriculture, are the main factors contributing to the deterioration of water quality. Microbial and chemical pollutants are the main factors responsible exclusively or in combination for various public health problems.

Safe water remains a key challenge as with the majority of the water available in the country, less than 20 percent is safe for drinking.[1] 16 million people in Pakistan have no choice but to collect unsafe water from unsafe sources and it is ranked in the top 10 countries (Table 1) with the greatest number of people living without access to safe water.[2] Three million people suffer from water borne diseases every year [3], and Pakistan is among the five countries that have the highest rate of diarrheal deaths.

Table 1: Top 10 countries without access to safe water

Country	Population
India	75.778 Million
China	63.167 Million
Nigeria	57.757 Million
Ethopia	42.251 Million
Domestic Republic of Congo	33.906 Million
Indonesia	32.286 Million
United Republic of Tanzania	23.239 Million
Bangladesh	21.088 Million
Kenya	17.206 Million
Pakistan	08.6 Million

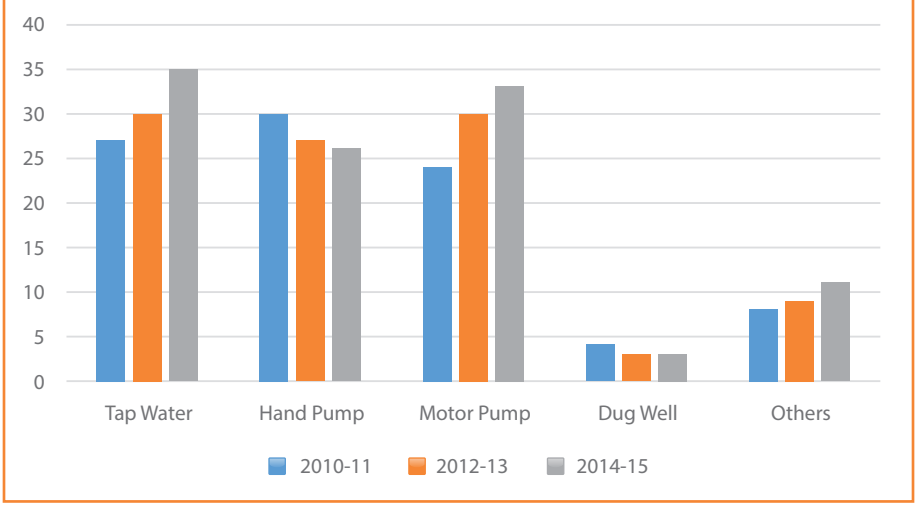
According to the Pakistan Social and Living Standards (PSLM) survey 2014-15[4], a national shift has been observed from tap water to motorized pumping in the last few years. The use of hand pumps has decreased, however, tap water is still the main source of drinking water in the country. Provincial level comparisons delineate that the number of households using tap water as the main source of drinking water is highest in Sindh (41 percent) followed by Khyber Pakhtunkhwa (KP) (35 percent), Baluchistan (33 percent) and finally Punjab (18 percent). In Islamabad, only 20 percent households are using tap water as the main source of drinking water.

Threats to drinking water quality include unsafe handling and storage in households: water drawn from safe sources may be contaminated by the time it reaches and is ultimately consumed by households. In some areas of the country, the availability of water is scarce. Poor governance, environmental degradation, over-extraction and climate change are further diminishing already scarce freshwater resources. Improvement of drinking water quality, such as point-of-use disinfection, can lead to a 45 percent reduction of diarrhea episodes.[5]

Over the years, Pakistan has developed

1 Pakistan council of research – Water quality status in Rural Areas of Pakistan (2010). Available at ttp://www.pcrwr.gov.pk/Btl_wr_report/Rural%20Areas%20Report/WQSReport.pdf
2 Wateraid, Water at what cost? The state of World's water 2016. Available at http://www.wateraid.org/uk/what-we-do/policy-practice-and-advocacy/research-and-publications/view-publication?id=3f44e1ad-49a3-425f-a59b-b5f2c1145fd9
3 PRI – Million sick due to lack of water in Pakistan. available at http://www.pri.org/stories/2009-04-20/millions-sick-due-lack-clean-water-pakistan
4 Pakistan Social and Living Standards Survey 2014. Available at http://www.pbs.gov.pk/sites/default/files//pslm/publications/PSLM_2014-15_National-Provincial-District_report.pdf
5 Center of Disease control and prevention. Global WaSH facts. Available at http://www.cdc.gov/healthywater/wash_statistics.html#seven]

Figure 1: Water demand scenarios in Pakistan



policies of Water and Sanitation, however, policy formulation has lacked consistent review and effective implementation. The proportion of the budget for WaSH as compared to other social sectors, is dismally low at 0.2 percent of the GDP.[6] In addition to this, the allocated funds are either not efficiently utilized or remain unspent. Strong coordination between different WaSH sector partners in the country is inevitable to help recognize clean water and sanitation as a basic human right in the constitution of Pakistan.

Sanitation related issues

Pakistan's population is expected to reach 230 million (presently at 190 million) by 2030, with its urban population increasing from 38.3 percent (2014) to 46.6 percent, with about 17 cities containing inhabitants exceeding one million. In urban areas, providing sanitation for all is a notoriously complex challenge, especially when trying to find alternatives to expensive sewerage systems. Fecal sludge management (FSM) is gaining more attention as a crucial link in delivering on-site sanitation because both its collection, through pit emptying and its treatment, are usually expensive, neglected and poorly developed. Data gap in the urban sector in Pakistan is one of the key limitations for sustainable urbanization and it compels planners and decision makers to take decisions based on estimates or even guesswork. Without sufficient knowledge of the demographic, economic, cultural, physical and environmental dynamics of Pakistan's cities, urban WaSH solutions designed by city authorities tend to leave out vital segments of urban society in terms of service delivery and also lead to poor resource identification.

Almost half of the country inhabitants live below the poverty line (earning less than USD 2 per day) and almost 21 percent of the total population is classified as "extremely poor" (earning USD 1.25 per day).[7] They bear the brunt of WaSH deprivation as only 13 percent of the poorest have access to improved sanitation as compared to 80 percent amongst the richest.[8] Open defecation is when people go out in fields, forests, open bodies of water, or other open spaces rather than using a toilet. It is incredibly dangerous, as contact with human waste can cause diseases such as cholera, typhoid, hepatitis, polio, diarrhea, worm infestation and under nutrition. An estimated 25 million people defecate in the open with variations between urban and rural areas: 21 percent in rural and one percent in urban.[9] The country is ranked ninth in the top ten countries with most people defecating in the open which is 32 people per square km, whereas ranked fourth in the top ten countries with the most improvement in access to sanitation between 1990 and 2015.[10]

Overall, there were only 13 percent households in 2014-15 that did not have sanitation facilities as compared to 15 percent in 2012-13. This varies greatly between urban and rural areas; one percent of urban households have reported no sanitation facility as compared to 21 percent of rural households. Provincial level comparisons of 2014-15 results delineate that Punjab has the highest percentage of households reporting no toilets (16 percent), followed by Baluchistan (13 percent), KP (12 percent), and finally Sindh (7 percent).

Pakistan is one of the only two countries in the world (other being Afghanistan) which has failed to stop transmission of polio and there are still substantial challenges to overcome before the prospect of a polio-free future for the children of this country becomes a reality. As long as a single child remains infected with poliovirus, children in all countries are at risk of contracting the disease. In areas with poor sanitation, the poliovirus virus easily spreads from feces into the water supply, or, by touch, into food. In 2015, Pakistan recorded 82 percent fewer cases as compared to 2014. The number of children paralyzed by polio at the end of June 2016 has been reduced by 60 percent over a year. However, the virus remains active in three core reservoir zones-the Khyber-Peshawar corridor, Karachi and the Quetta block, as well as areas outside of the core reservoirs zones like northern Sindh and Bannu district in KP.[11]

At present, 91 percent of Pakistanis have access to improved water, and 64 percent to improved sanitation.[12] This is built on encouraging examples of community-led sanitation services by adopting the Pakistan Approach to Total Sanitation (PATS) leading to a large number of communities attaining status of open defecation free (ODF). Currently, there is a dearth of new or improved WaSH technology options in both rural and urban realms. However, there is an opportunity to bridge this gap by bringing in national and regional best practices on affordable technologies. A number of academic and research institutions exhibit research capacity, but lack the focus to generate practical WaSH technologies. This is a great opportunity to link academic and research institutions with the private sector.

Hygiene related issues

In Pakistan, every year 39,000 children under the age of five die due to diarrhea, out of which 88 percent is attributed to unsafe water supply, inadequate sanitation and hygiene.[13] Education and communication are important components of promoting hygiene, however education alone does not necessarily result in

6 World Health Organization – Glass 2014. Available at http://www.who.int]

7 Government of Pakistan – Poverty safety social net survey (2014-15). Available at http://finance.gov.pk

8 UNICEF – Progress on Sanitation and Drinking Water updates (2015) Available at http://www.unicef.org

9 World health organization and United Nations Children Fund 2015 "25 years of progress on Sanitation and Drinking water – 2015 update and MDG assessment", Joint Monitoring programme for Water supply and Sanitation

10 WaterAid, 'It's no joke. State of the world toilets 2015'. Available at http://www.wateraid.org/uk/what-we-do/policy-practice-and-advocacy/research-and-publications/view-publication?id=3f44e1ad-49a3-425f-a59b-b5f2c1145fd9

11 UNICEF Pakistan. Available at http://www.unicef.org/pakistan/overview.html

12 World Health Organization – Glass 2014. Available at http://www.who.int

13 World Health Organization Global Health Observation Data. Available at http://apps.who.int/gho/data/view.main.ghe1002015-pak?lang=en

improved practices. An estimated 46 percent of the population does not have a handwashing facility at home with soap and water.[14] 57 percent households in urban and only six percent households in rural areas have a garbage collection system.[15] Promoting behavioral change is a gradual process that involves working closely with communities, studying existing beliefs, defining motivation strategies, designing appropriate communication tools and finally, encouraging practical steps towards positive practices. Research shows that regular handwashing with soap can reduce the number of incidents of diarrhea, a disease which can be deadly for children, by around 50 percent.

Efforts are needed to develop strategies and tools to encourage handwashing promotion by community health and outreach workers and work with schools to empower children as hygiene ambassadors and agents of change within their families and communities. One of the biggest challenges to ending open defecation is not just providing clean and safe toilets, but changing the behavior of entire communities. A large part of the WaSH sector working on ending open defecation should focus on generating awareness, sharing information and spurring behavior change in an effort to bridge the gap between building toilets and their proper use.

Linkages of WaSH with other Sectors

WaSH and Climate Change

Glacier melt in the Himalayas is projected to increase flooding which will affect water resources within the next two to three decades. Endemic morbidity and mortality due to diseases primarily associated with floods and droughts are expected to rise. Increases in coastal water temperatures would exacerbate the abundance of cholera. The impact of climate change will also aggravate the existing social inequalities of resource use and intensify social factors leading to instability, conflicts, displacement of people and changes in migration patterns.

WaSH and Health

Water, sanitation and hygiene are fundamental to health. Despite progress on child mortality, infectious diseases still pose the largest threat to the health of young children. An infection such as diarrhea is the third biggest killer of children under five [16] and almost 90 percent of cases of diarrhea are caused by poor WaSH.[17] 50 percent of under-nutrition is due to a lack of WaSH,[18] and under-nutrition is an underlying risk factor for around 30 percent of under-five deaths.[19] Repeated episodes of diarrhea can make under-nourished children predisposed to pneumonia.[20] A lack of hygiene and sanitation and the associated diarrhea also contributes to stunting and inhibited cognitive development in millions of children worldwide. Globally, 2.5 billion people still lack access to sanitation,[21] causing water sources, homes and surrounding environments to become contaminated and contributing to poor health and non-preventable child deaths.

WaSH and Education

Fulfilling every child's right to water, sanitation and hygiene education remains a major challenge for policymakers, school administrators and communities in many countries. Each year, children lose millions of school days because of water related illnesses, of which majority are lost due to diarrhea alone. More than 40 percent of diarrhea cases in schoolchildren result from transmission in schools rather than homes.[22] Improving WaSH conditions in schools can also help to prevent worm infestations, of which 100 percent of annual cases globally can be attributed to poor sanitation and hygiene. By integrating cost-effective and sustainable WaSH solutions with education programs, dramatic decrease in child morbidity can be achieved while improving access to and effectiveness of education. Cost-effective, scalable and context-relevant interventions, handwashing with soap and integrating hygiene education into curricula are key elements to improving WaSH in Schools.

In Pakistan, there is neither a National Plan of Action for WaSH in Schools, nor a national budget allocation in schools programming. The Ministry of Education is the lead agency for the implementation of WaSH in schools programming. One out of every three schools has no drinking water.[23] Several studies conducted in Pakistan reflect the lack of access to facilities required by adolescent school going girls to maintain menstrual hygiene. These include the lack of private and clean toilets with sufficient water and soap, and free or subsidized sanitary napkins or any mechanism for providing awareness on appropriate menstrual hygiene management (MHM) practices.

WaSH and Gender

A lack of access to WaSH affects women and girls disproportionally, due to biological and cultural factors. Women are often vulnerable to harassment or violence when they have to travel long distances to fetch water, use shared toilets, or practice open defecation. Women and girls often wait until nightfall to defecate, which increases the risk of assault. Many choose to 'hold it' or limit their consumption of food and drink to delay the need to relieve themselves, which can increase the chance of urinary tract infections. The shame and indignity of defecating in the open also affects women's self-esteem.[24]

Lack of access to WaSH at home and school has a negative impact on children's education, particularly for girls. Opportunities for learning are lost when children have to spend time collecting water or finding a safe place to defecate or urinate in the open; this is especially a problem for girls due to their additional burden of MHM. A lack of access to drinking water and toilets during the school day affects the learning environment for both students and teachers. Adolescent girls in particular are disinclined to use school toilets that are dirty or lack privacy, especially when they are menstruating, and this affects their attendance.

With improved access to WaSH, women have more time to undertake income generating activities. WaSH programmes also provide women with the water needed to carry out economic activities and can create opportunities for paid work. Easier

14 World health organization and United Nations Children Fund 2015 "25 years of progress on Sanitation and Drinking water – 2015 update and MDG assessment", Joint Monitoring programme for Water supply and Sanitation

15 Country paper on sanitation, Pakistan. South Asian Conference on Sanitation VI. 2016

16 Child Health Epidemiology Reference Group (CHERG) 2012

17 World Health Organization (2008) Safer water, better health: Costs, benefits and sustainability of interventions to protect and promote health. Available at: http://whqlibdoc.who.int/publications/2008/9789241596435_eng.pdf

18 World Health Organization (2008) Safer water, better health: Costs, benefits and sustainability of interventions to protect and promote health. Available at: http://whqlibdoc.who.int/publications/2008/9789241596435_eng.pdf

19 World Health Organization (2012) Children: Reducing mortality. Fact sheet 178. Available at: www.who.int/mediacentre/factsheets/fs178/en/index.html

20 Schlaudecker E P, Steinhoff M C and Moore S R (2011) Interactions of diarrhea, pneumonia and malnutrition in childhood: Recent evidence from developing countries. Current Opinion in Infectious Disease, vol 24, no 5, pp 496-502

21 WHO/UNICEF Joint Monitoring Programme (JMP) (2013) Progress on drinking water and sanitation, 2013 update. Available at: www.wssinfo.org/fileadmin/user_upload/resources/JMPreport2013.pdf

22 WHO/UNICEF (2010). Water, Sanitation and Hygiene. Retrieved [http://www.unicef.org/media/media_45481.html]

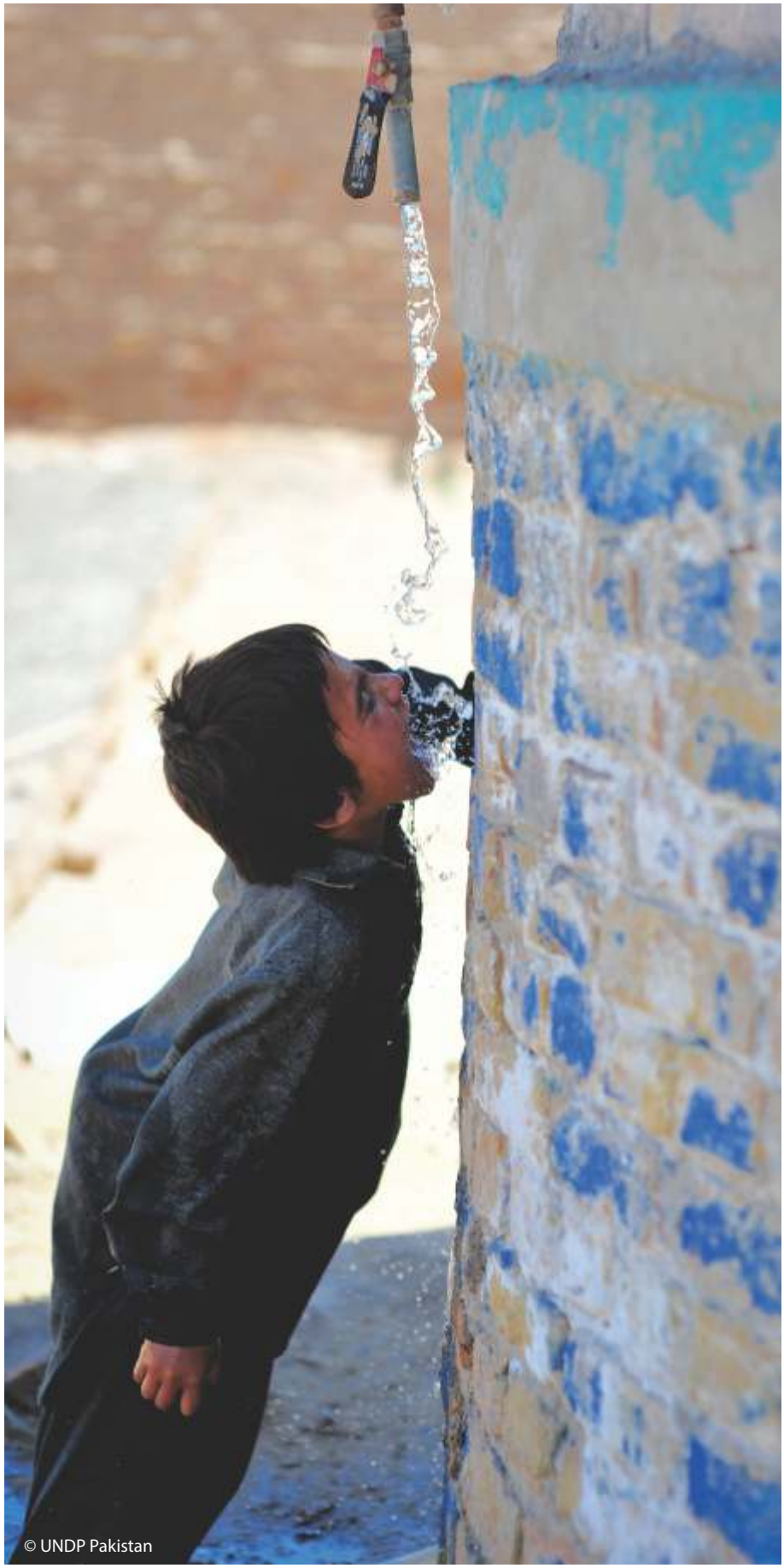
23 Alif Ailaan regional factsheets 2014. Available at http://alifailaan.pk/fact-sheets

24 WaterAid post 2015 toolkit. Available at https://sustainabledevelopment.un.org/getWSDoc.php?id=2428

access to water can, for example, enable a woman to water a kitchen garden, improving her family's food security and providing an opportunity to earn money by selling the surplus. Women's involvement in decision-making about water resources and in WaSH programmes is critical to their empowerment, but it is important that they are not overburdened with additional unpaid work on top of their existing responsibilities. In general, WaSH is essential for the social and economic development of women, contributing towards gender equality and the realization of their rights.

Way forward

- There is a need to develop and promote both physical and approach based models to deliver WaSH services, especially for most vulnerable communities of Pakistan.
- Promote sustainable technological assistance to the government to make their programmes inclusive and more sustainable and strengthen institutional capabilities for delivering inclusive WaSH services effectively and sustainably.
- Launch campaigns with collaborative efforts on Hygiene behaviors, engaging all relevant stakeholders, culminating into a moment for change in social norms on WaSH behaviors.
- Promote wider understanding between stakeholders, highlighting roles and responsibilities that pave the way towards sectoral reforms and more effective delivery, targeting the poor and marginalized.
- Collaboration with counterparts from other social sectors, particularly education, health, nutrition and gender, to demonstrate the benefits of joint working approaches and collaboration.
- Undertake joint sectoral reviews and provide evidence and sector blockages and opportunities for better coordination. Support sector coordination to encourage partners to undertake joint planning, review, learning and adoption.
- High impact advocacy champions at senior levels of government and political leadership supported by evidence based knowledge materials and technical backstopping towards WaSH rights legislation and for development, as well as fiscal prioritization.



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Interview

Shams-ul-Mulk

Former Chairman
Water and Power Development Authority (WAPDA)

say that again

"...We need to educate the users and public, the farmers, and other consumers on what are better ways to utilize this limited resource."

Is there sufficient awareness, especially among key policy makers, regarding the impending water crisis in Pakistan and its repercussions on the social and economic landscape? What should be done to enhance awareness and increase commitment of policy makers in this important issue?

Our key policy makers have acted like absentee landlords of water in Pakistan. We need to educate the users and public, the farmers, and other consumers on what are better ways to utilize this limited resource. Because of this absentee landlordism, water has become the property of the landlords and the poor users simply do not get their share. A range of other factors, including water theft, further exacerbates these issues. The worst example of it is in Sindh. In Khyber Pakhtunkhwa, the 'Pushtoon' society is still a lot more egalitarian, so the problem is not as pronounced, but it still exists. In general, the landlords would not want the poor to become economically self-sufficient, as that would enable them to challenge the landlords. So, this water issue is also very political in nature.

Is water management a priority of Pakistan's overall policy framework? What policies need to be adopted to ensure sustainable use of water resources?

Pakistan's water policy does not exist. The Minister of Water and Power wanted to frame it, and we discussed the possibility. In 2001, a committee was formed which was headed by me and a draft was framed at the expressed request of the Ministry of Water and Power. It was a very comprehensive document. It is most unfortunate that Pakistan's cabinet has simply never allocated the time for its review and approval.

What are the coordination issues within provinces and amongst sectors of the economy with regards to the distribution of water? What should be done to improve water resource management in the long-term?

It was in a marathon meeting of the four Chief Ministers of Pakistan that a joint memorandum of Water Rights of the provinces was agreed. A document, called "Apportionment of the Waters of Indus River System between the provinces of Pakistan" was signed on 16th March, 1991. The apportionment accord was agreed to be implemented by an institution named as Indus River System Authority (IRSA). IRSA was established through an Act of the Parliament in 1991. It has successfully carried its functions to the satisfaction of all provinces.

However, the major problem that continues to exist is the extreme variability of river flows season-wise; 84 percent of flows in summer and only 16 percent in winter. With a Kharif to Rabi ratio of 2 to 1, our seasonal needs are about 66 percent in summer and 34 percent in winter, showing surpluses of 18 percent in summer and shortages of 18 percent in winter. The surpluses of summer create floods, inflicting major damages to the infrastructure in the Indus Plains, and shortages in water disable Rabi crops from its optional yields. Owing to the lack of a strong government, this disability continues to hurt Pakistan and its economy.

say that again

"...Access to information and knowledge networking is a key factor in effective water resources management."

Muhammad Tahir Anwar

Director General
Federal Water Management Cell
Ministry of National Food Security and Research

Is there sufficient awareness, especially among key policy makers, regarding the impending water crisis in Pakistan and its repercussions on the social and economic landscape? What should be done to enhance awareness and increase commitment of policy makers in this important issue?

There is not sufficient awareness among key policy makers, at federal as well as provincial level, regarding the impending water crises in Pakistan, which is posing a threat to the country's security, stability and environmental sustainability. Policy and decision makers face considerable barriers in access to accurate and crucial water resources information. Access to information and knowledge networking is a key factor in effective water resources management. There is a need to develop and launch a water information portal that can provide accurate information on water resources in a format easily comprehendible by policy makers. Apart from this, organizing seminars for enhancing awareness and enabling an understanding of water issues among key policy makers and all other relevant stakeholders, is also an integral component.

Is water management a priority of Pakistan's overall policy framework? What policies need to be adopted to ensure sustainable use of water resources?

Water management has not been given due priority in Pakistan's overall policy framework. Much emphasis has perpetually been placed on the management of river basin waters, whilst management of groundwater and rainwater/hill torrents have not been given due consideration. As river water supplies become erratic owing to low storage capacity and climate change, there has been significant increase in the use of groundwater for irrigation purposes resulting in a negative groundwater budget on an overall basis. Further, 18 MAF worth of rainwater/hill torrent potential has not been realized in the overall policy framework. It is therefore imperative that a comprehensive policy framework (inclusive of river basin, groundwater and rainwater/hill torrents) be developed and adopted to ensure sustainable use of scarce water resources. It is also imperative that the National Water Policy be finalized and approved at the earliest.

What are the coordination issues within provinces and amongst sectors of the economy with regards to the distribution of water? What should be done to improve water resource management in the long-term?

There hardly appears any coordination with regards to the distribution of scarce water resources, further threatened due to climate change. Under the 1991 Water Apportionment Accord, IRSA has been playing an effective role for the distribution of irrigation water to the provinces. However, it lacks the capacity to address water issues arising as a result of the changing climate. In order to improve water resources management in the long-term, it is imperative to bring together all relevant sectors of the economy on a common platform and for an integrated policy framework to be developed. Institutional framework at the federal and provincial levels for integrated management of water resources needs to be strengthened, along with proper identification of the roles of federal and provincial stakeholders in order to enhance understanding and develop sustainable water resources management in the long-term.

Interview

say that again

"...A mass awareness campaign needs to be launched on the importance of water, its impacts on all sectors of economy and promoting efficient water management practices..."

Dr. Muhammad Ashraf

Chairman
Pakistan Council of Research in Water Resources (PCRWR)

Is there sufficient awareness, especially among key policy makers, regarding the impending water crisis in Pakistan and its repercussions on the social and economic landscape? What should be done to enhance awareness and increase commitment of policy makers in this important issue?

According to all indicators, Pakistan is fast becoming a water-scarce country. However, there is little awareness of this looming disaster amongst stakeholders, particularly policy makers. They cannot foresee the real picture of its repercussions on social and economic fronts. The following actions may help in awareness raising of policy makers:

- Engaging them through scientific-based evidence so that the seriousness of the situation is realized;
- Large scale mass awareness delineating the role of each sector of the economy; and,
- Synthesizing the latest methods of diffusion and adoption and, scaling up of promising water management practices.

Is water management a priority of Pakistan's overall policy framework? What policies need to be adopted to ensure sustainable use of water resources?

Water management is a part of Pakistan Vision 2025 which envisages improving the efficiency of usage in agriculture by 20 percent. Similarly, it is also part of the Sustainable Development Goals 2030 Agenda for which Pakistan is a signatory. Water should be managed at all levels including domestic, industrial and agricultural. The Draft National Water Policy should be approved which provides policy guidelines for sustainable management of water resources. Moreover, provinces should develop their own strategies within the framework of the National Water Policy.

What are the coordination issues within provinces and amongst sectors of the economy with regards to the distribution of water? What should be done to improve water resource management in the long-term?

The Pakistan Water Apportionment Accord 1991 provides a framework regarding the distribution of water among provinces, with the Indus River System Authority (IRSA) conducting the job reasonably well. However, there is not a single institution at the federal level that can coordinate with the provinces on water-related issues and the different sectors of the economy. Nevertheless, the Draft National Water Policy proposes to establish a National Water Commission (NWC) that will not only ensure implementation of the water policy but will also coordinate with the provinces. A mass awareness campaign needs to be launched on the importance of water, its impacts on all sectors of economy and promoting efficient water management practices and technologies to all stakeholders - right from the policy makers to the end users.

say that again

"...the obstacle is not that the system is not massive enough, in fact, the obstacle is that it has not been effectively utilized."

Sadia Tariq Usmani

Head - Environment division
Youth Affairs Committee, DMC Central (Karachi)
Secretary of Environment, Youth Parliament-Sindh Cabinet (2016-17)

Is there sufficient awareness especially among key policy makers regarding the impending water crisis in Pakistan and its repercussions on social and economic landscape? What should be done to further enhance the awareness and increase commitment of policy makers to this important issue?

I believe that policy makers are well aware of the impending water crisis and its repercussions, however, this is not an area of focus as far as policy is concerned. Serious thought needs to be invested as to how in the face of diminishing resources, Pakistan can develop sufficient storage capacities for the future. In 1950, Pakistan had around 5,000 m^3 per capita per year of freshwater resources, which shrunk to 1,500 m^3 by 2012. To put it in perspective, a country is declared water scarce when this figure stands at around 1000 m^3.[1]

One projected methodology is to introduce water usage fees, particularly for those that use irrigation to water their crops. As of 2005, the World Bank estimated that the water usage fee for Punjabi farmers should be around 1,800 PKR per hectare. The real rate was close to around 150 PKR per hectare.[2] Implementing a proper pricing system will not only raise revenue for the maintenance and repair of irrigation infrastructure, but will also compel large landowners to think twice before wasting water. This market oriented system can also work in urban areas. Studies have shown that the cost of a modern municipal water system is less than the economic costs of a poor water system.[3]

The real solution lies in changing the mindset and strategy. Whilst focus in the past has always been on building infrastructure to combat water shortages, the real problem lies in the actual shortage itself. Therefore, focus should be placed on including the topic in curriculums taught throughout the country in order to enhance awareness, and also to increase conservation of water resources itself. Focus on recycling existing water and reusing it is the need of the hour. In a country that houses one of the most important contiguous irrigation systems in the world, the obstacle is not that the system is not massive enough, in fact, the obstacle is that it has not been effectively utilized.

Is water management a priority of Pakistan's overall policy framework? What policies need to be adopted to ensure sustainable use of water resources?

Had water management been a priority, then water scarcity would not have been a present challenge for the country. We should look towards how developed countries have tackled the issue and work towards adopting similar strategies locally.

What are the coordination issues within provinces and amongst sectors of the economy with regards to the distribution of water? What should be done to improve water resource management for the sustainable use of water?

The major coordination issue is the inability of policy makers and other stakeholders to assemble on a single platform and seriously assess the issue. Apart from this, the building of more dams and reservoirs is also crucial in terms of saving and storing water. Pakistan is rapidly moving towards water scarcity and if this issue is left unaddressed, it will soon lead to water wars.

1 Introduction. Running on Empty: Pakistan's Water Crisis. Ed. Michael Kugelman and Robert M. Hathaway. Washington, D.C: Woodrow Wilson International Center for Scholars, 2009. 5-27. Web. 16 May 2014

2 World Bank. 2005. Pakistan - Country water resources assistance strategy: water economy running dry. Washington, DC: World Bank.

3 Altaf, Samia. "Public Health, Clean Water, and Pakistan: Why We Are Not There Yet." Running on Empty: Pakistan's Water Crisis. Ed. Michael Kugelman and Robert M. Hathaway. Washington, D.C: Woodrow Wilson International Center for Scholars, 2009. 169-75. Print.

Interview

say that again

"...The water must be distributed judiciously not only at the provincial level, but also at the main canal, branch canal, distributary canal, as well as at the minor level."

Prof. Dr. Abdul Latif Qureshi

Professor
U.S.-Pakistan Center for Advanced Studies in Water (USPCAS-W)
Mehran University of Engineering and Technology

Is there sufficient awareness, especially among key policy makers, regarding the impending water crisis in Pakistan and its repercussions on the social and economic landscape? What should be done to enhance awareness and increase commitment of policy makers in this important issue?

There is no issue of awareness among policy makers regarding the upcoming water scarcity, the only restrictions are of political will and priorities. There is a dire need for coordination amongst relevant legislators dealing with Water and Power, Environment, Climate change and Economic affairs, to mobilize and advocate the cause in assemblies, as well as, motivate other legislators to follow suit as well. Mass awareness among people should be increased to exert pressure on elected representatives. Research and development institutes and academia should also be streamlined and urged to take up the matter on priority basis.

Is water management a priority of Pakistan's overall policy framework? What policies need to be adopted to ensure sustainable use of water resources?

No concrete efforts are visible to understand water management as a priority in Pakistan.

What are the coordination issues within provinces and amongst sectors of the economy with regards to the distribution of water? What should be done to improve water resource management in the long-term?

There are very serious concerns and disputes amongst provinces, especially on water regulation and distribution. The upper riparian holds all head works for water control, which creates a sense of disloyalty and mistrust between the provinces. There is a serious need to develop trust in provinces in the lower Indus region. The water must be distributed judiciously not only at the provincial level, but also at the main canal, branch canal, distributary canal, as well as at the minor level.

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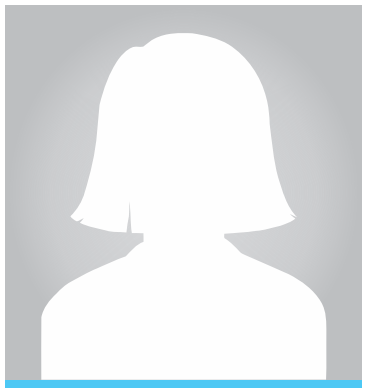
Youth Voices

Farhan Laghari

Student
Majors in Water Studies

> Lack of accountability and rampant corruption significantly impacts upon the distribution of water. Reducing the influence of politics in water governance is paramount in achieving solutions. Moreover, the introduction of learning programs in rural areas and research is mandatory in different application methods.

> The inversely proportional relationship of supply verses demand is likely to be the root for many problems that will erupt in the future. While the world progresses in technological innovations, Pakistan seems to be regressing. Focus on better engineering technologies that offer automated solutions, as well as better early warning systems are steps for mitigation that require more planning and research.



Fatima Fazal

Student
Majors in Water Studies

Shahzad Hussain Dahri

Student
Majors in Water Studies

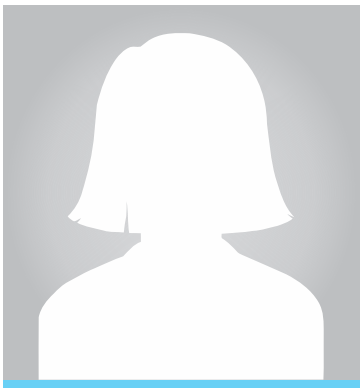
> Unskilled management for agricultural awareness programs, ineffective management to transfer farmers' knowledge for agricultural practices and unnecessary wastage of water are major issues. Effective and optimum utilization of water, increased awareness programs and proper record keeping regarding water applications and utilization, are required to curb water issues in Pakistan.

Youth Voices

Ainulibad Shah

Student
Majors in Water Studies

> Siltation in canals and water losses due to the unequal leveling of water courses results in an almost 60 percent loss of water. New engineering tactics and techniques should be applied to decrease seepage losses and proper law and order procedures must be used to control these problems.



Gulnaz Aslam

Student
Majors in Water Studies

> How can you talk about issues when the basic understanding is not even there? Awareness is an ever building issue-something as small as turning off the tap while brushing your teeth can help save so many gallons of water. Sustainable long term planning is key. Currently, there is not much emphasis placed on integrating better water policies and practices. It is the thinking at the top levels that needs to change in order to create a domino effect of sorts.

Shahid Latif Bhutto

Student
Majors in Water Studies

> Illegal supply of water and water hydrants are a major issue of utility. There is need for small dams to enhance capacity for storage. Moreover, water salinity is a major problem for agriculture as well as drinking thereby impacting health. Filter plants and drop and sparkler systems should be developed.

DEVELOPMENT ADVOCATE
PAKISTAN