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Water Scarcity in Pakistan: Resource Constraint or Mismanagement

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Abstract

The current study has addressed major issues associated with water resources, gap analysis for the allocation, distribution mechanism, and recommendation for efficient utilization. This study specifically addresses the role of political factors in giving rise to water crisis in Pakistan, the factors hampering effective implementation of Indus Water Treaty, and the role of local politics in water crisis in Pakistan. Moreover, it is also focused on the discrimination of provinces in terms of water apportionment. The study also analyzes, whether effective implementation of the 'National Water Policy 2018' would lead to efficient water resource management. The conclusion and recommendations comprise a mixture of qualitative and quantitative analysis of events, situations, and numerical data from reliable sources. Resultantly, it was inferred that water availability is emerging as the definite challenge for individuals and communities across the globe. An urgent concerted effort is required to cope up with the exponential demand and its efficient utilization. However, the water production and supply management has not been developed in line with the critical increase in population growth, intensive water use for agrarian economy, and fast-growing industrialization. Developmental activities can only be sustained if natural resources are also preserved for the next generations and their depletion effect is addressed for longer terms. It is crucial to reformulate the current national water policy by consensus and implement it with its inbuilt regular updating process. Water securities must be prioritized by legislators, politicians, and policymakers. Politics over water security worsens the problems and more water injection in national grid is becoming highly linked with the national level politics.

***Keywords*:** distribute mechanism, effective implementation, natural resources, water production

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Introduction

Water scarcity refers to the deficiency of ample fresh water resources to cater the demand of a specific area, which is affecting every continent with over 2.8 billion people at least once a month in a year. This situation has undesirable impacts on the livelihoods and food security of millions of Pakistanis who depend on irrigated farmlands. An increasing concern has been witnessed pertaining to the potential impacts of Pakistan's already stressed water resources, particularly those within the Indus Basin. The human right of access to water for various purposes including personal, domestic, irrigation, and other uses is fundamental in every society which is essential for human survival. According to the figures given by the Population Action International 1993, up to the year 2025, the per capita water availability would be only 837m^3, which shows that Pakistan is reaching a situation of chronic water stress. Water is an essential resource for sustaining life. Pakistan is currently facing a dilemma of widening between freshwater demand and supply gap. The quantity of water supply is decreasing, while the increasing population is causing the demand of fresh water to increase. This gap could only be fulfilled by management of existing water resources and by constructing additional water reservoirs. The present scenario brings in several challenges and new dimensions of water management. High population growth, rapid industrialization, and urbanization have heavily contributed towards the scarcity of water. Poor management of water infrastructure for big and small dams, flood water, and water losses of irrigation system result into floods and droughts in some areas, simultaneously.

Pakistan is also facing a continuous rift over water among its provinces. The provinces are apprehensive of losing their share of water which leads to peruse their own interests rather than national interests. Pakistan has recently passed national water policy in 2018. The institutions in Pakistan are also working in silos as each institute deals with particular aspect of water sector. These challenges need pragmatic policies and effective water regulations.

The issues pertaining to water supply need to be addressed by the strategic intervention both on demand and supply side. The industrial and agriculture sector should use water more judiciously and efficiently. The agriculture sector also demands close assessment and alternative ways for

utilization and optimization along with research for water intensive crops and water trading as an option for the most productive purposes.

The water profile of Pakistan changed from abundant water to stressed water and to scarce water only over the last few decades between the period 1990-2015. The water availability per capita has reduced from 2172 cubic meters to 1360 cubic meters. This alarming reduction has severely impacted the human development of the country. The depletion of water resources coupled with water losses has adversely damaged the agricultural, industrial, and domestic sectors of the country. Moreover, it has also affected the water security which, in turn, has made it difficult to fulfill the increasing food needs of the country. Pakistan is in dire need of integrated water management system; with a specific focus on its resource availability, supply mechanism, and consumption behaviors. Water apportionment between India and Pakistan has been a long-standing political issue. The water crisis is not only affected by international politics but also by local politics. The distribution of water as per regional and sectoral requirements is one of the important responsibilities of the state. The crisis also occurred due to the lack of efficient water policies and their implementation. The construction of dams has also been affected by trans boundary and provincial politics.

The economy of Pakistan largely depends on agriculture sector since it contributes around 25% to the national GDP and is a livelihood of about 60% people of the country. Large-scale irrigation system irrigates 21 million hectares (Mha) of cultivatable land and 14.8 Mha is irrigated by canals, while other 5 Mha is rain/flood dependent. River outflow covers 65% of cultivated land, wherein the other is dependent on 43 main canals. Mangla and Tarbela dams support the canal network. However, the requirement of surface water has increased manifolds due to growing population and agriculture sector growth. Consequently, the crop water requirement contributes 40% to 50%. Groundwater in the sweet water zone and river supplies in the saline groundwater areas cater for water demand of the industrial and domestic sector. Pakistan's little storage capacity of 150 cubic meters per capita implies that the Indus Basin can barely store 30 days of water.

Indian Prime Minister Narendra Modi has recently announced that he would be "bringing Indus water back to India". This has raised serious concerns for Pakistan. The revision of the treaty is highly interstate interest

dependent. Furthermore, on western rivers, India has started building dams and Pakistan has grave reservations on the Wullar Barrage, Ratel, Kishan Ganga, and Sawalkot dams. This would cause a serious threat to accessibility of water for agriculture, drinking, and domestic purposes.

Kalabagh dam is the major political issue since the construction of this dam has been halted due to political resistance. Moreover, smaller provinces refused its construction as well. The big and small dams have been the victims of political issues in Pakistan which has affected the water availability in country to a large extent. Hydro politics is not allowing the construction of any reservoir in the country. The current research is limited to political factors hampering the water resource development.

Literature Review

The review of literature comprised primary and secondary sources, such as Water Security in Pakistan: Issues and Challenges by UNDP, Water Security Issues of Agriculture in Pakistan by Qureshi, Indus Water Conflicts by Habib Ullah Magsi, and The Vulnerability of Pakistan's Water Sector by International Institute of Sustainable Development. The Policy Papers of Government of Pakistan were also consulted, such as National Water Policy 2018, Water Commission Report 2018, and Indus Water Treaty. The data from various sources of federal and provincial organizations was also analyzed thoroughly.

- The International Institute of Sustainable Development has discussed the vulnerability of Pakistan's Water Sector in relation to different contributing factors of water scarcity and their mitigation strategies.
- Dr. Shahid Ahmed in his analytical paper, on water scarcity, has mentioned that the entitlement of each province is extremely high as compared to water availability, which is the main reason for conflicts over water between the provinces. He also highlighted that these entitlements were given due to expected increase in the storage capacity which still remains the same. He further appreciated the role of Council of Common Interest in the amicable distribution of water in the past.
- Riaz Hussain Qureshi and Muhammad Ashraf have compiled the reports for the policy makers, water managers, and other stakeholders in water security issues of agriculture in Pakistan. The inherent benefits

of irrigation system bring huge management and operational challenges for the efficient water distribution practices.

- Water commission report in 11th five-year plan highlights the threats of major canal commands and watercourses in IBIS (Indus Basin Irrigation System).
- United States' institute of peace in its report on "Understanding Pakistan's Water Security Nexus" by Daanish Mustafa, Majed Akhter, and Natalie Nasarllah emphasized further that in Pakistan, water is working as an indirect driver for local political settlements and external political fragility.
- Hydro Politics and Water Wars in South Asia by Iqtidar H. Siddique and Water Politics by David L. Feldman also highlighted the cause and effect relationship of hydro politics in different regions and Indus Basin, in particular.
- India's Dams and Pakistan's Water Crisis by Safina Nabi and Syeda Sana Batool provides a concluding statement, "The country is being strangled by a chronic water shortage that stands to exacerbate tensions with its giant eastern neighbor."
- Water Scarcity in Pakistan Issues and Options by Dr. Muhammad Ashraf (2018) suggests practicable solutions for mitigation of water scarcity including increase in water storages, watershed management, recycling wastewater, and drainage water and mass awareness campaign.

Thus, after an extensive review of the aforementioned works, it can be seen that the local political climate and trans-boundary issues have been a major cause of water scarcity within the country. The issues highlighted in the current study are quite complex and need integrated approach as evident in the aforementioned works.

Research Methodology

To arrive at the conclusion and recommendations, chronological, descriptive, and analytical methods were employed on the secondary data collected from various published and unpublished sources. The research was qualitative in nature involving analysis of events, situations, and numerical data. Interpretive method was used to interpret different events

in political and historical context and to draw conclusions. The data was extracted from reliable sources, such as official reports, newspapers, and data containing opinions was avoided to keep the research free from biases.

The data by different government organizations was used for vulnerability analysis. Critical analysis of different water instruments was conducted to assess the implications in the changing demographic and water practices. Time was the major constraint of the study. While considering the other factors as constant, the current study targeted main factor, that is, political factor which impedes the exploration of various channels and methods of water management. The data of different water sectors was analyzed with the extrapolative effect. The research was also limited to hydro politics around the Indus basin.

Organization of the Paper

The current study focused on the political issues faced by Pakistan with regard to water distribution, supply, and usage. The first section of the study introduced the water profile of Pakistan. Moreover, it also presented a brief overview of different issues affecting water security in Pakistan and its implications on the economy and other sectors of the country. The second section introduced political issues and challenges faced by Pakistan in terms of water distribution in historical and legal context. The Indus water treaty, Pakistan's reservations on construction of dams by India, and its implications were also discussed. The issue of Kalabagh dam was also dissected at length. The third section highlighted the options for Pakistan for the development of water resource in Indus Basin. The recently introduced, The National Water Policy 2018, was also discussed in terms of 'Politically Exclusive Water Governance Framework' and Strategic Water Management Intervention for sustainable economic growth in Pakistan.

Eventually, the research concluded with recommendations to overcome the political issues faced by country in water resources management.

Water Profile of Pakistan

The current renewable water resources of Pakistan are estimated to be 229 billion m^3 or around 1,100 m3 per capita including Indus Basin (Hassan, 2016). Sustainable consumption of water is a challenge for Pakistan. High population growth, irrigation, and industrialization have resulted in drought. Per capita availability of water has also declined abruptly.

Pakistan has the world's fourth highest water usage rate. The rate of water consumption is very high on per unit of GDP in m^3. Pakistan's per capita water availability is 1,014 m^3 although, in 2015 it was about 1500 m^3. The agriculture sector of Pakistan is water intensive and irrigated through old canal systems. This water is underpriced and recovers quarter of its maintenance and operating costs. The canal water is not optimally utilized with heavy water losses under present irrigation system. High population growth rate is also making the situation worse.

Table 1

Water Distribution in Pakistan

Water Distribution Dynamics		Three Hydrological Units
Glacier-melt Runoff	65%	• Indus basin, covering an area of over 566,000 km^2 • Kharan desert in west Balochistan with its inland drainage. • The arid Makran coast along the Arabian Sea in south
Rainfall (Liquid Portion)	35%	
• Monsoon	65%	
• Winter	25%	
Lower Indus Plain	< 100 mm	Total watershed area of the Indus basin
Upper Indus Plain	> 75 mm	944,000 km2 (60% Pakistan)

Note. Source. National Water Policy, Vol II. January 2002

Higher rate of water use through glaciers runs off and wastage of water in Monsoon season are important dynamics of hydrology of Pakistan. Wherein, large chunks of barren lands in Kharan and Makran coasts suffered scarcity of water since decades and very high on poverty index.

Table 2

Population vs. Water Availability in Pakistan

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

Note. Source: Ahmad, S. 2008. Land and water resources of Pakistan

In Pakistan, per capita water availability was 5000 $m^{3,}$ in early 1950s which has reduced to 1200 m^3 with 40% drop in storage capacity of three major reservoirs (Cincotta et al., 2003). The United Nations calculates water resources' withdrawals with its capacity to percentage of Total Water Renewable Resources (TRWR). On the stress indices, the stresses are considered high above 25% and Pakistan touches 74%, whereas India has 34%. Indus water planning in this regard is very precarious for social stability (Mustafa et al., 2013).

Resources Availability

Water storage capacity is very low in Pakistan. Pakistan has less than 150 $m^3$of storage capacity per inhabitant, wherein US has 5000 m^3 and china has 2,200 m^3 per person. The dams of Murray-Darling river in the US have capacity of 900 days of runoff river, Orange river in South Africa 500 days, India 120-220 days, wherein Pakistan can hold merely less than 30 days capacity in Indus basin (Sherani, 2019).

Water resources are dependent on surface water, monsoon rainfall, and groundwater. Indus flows and its allied streams mainly contribute to surface water-resources. Five major tributaries of Indus are Jhelum, Ravi, Chenab, Beas, and Sutlej and three minor tributaries are the Harow, Siran, and Soan. There are minimum flows of Indus and its tributaries during winters. Moreover, there are many streams and seasonal hill torrent tributaries, besides these major rivers.

Table 3

Estimated Ground Water Resources in Provinces

Provinces	Million (Acre /Feet)	Billion (m3)
Punjab	43.2	52.8
Sindh	18.4	22.5
Balochistan	2.1	2.5
KPK	3.1	3.8
Total	66.8	81.6

Note. Source. National Water Policy, Vol. II January 2002

About 70% of the annual rainfall occurs in the months of June to September. Mean annual rainfall ranges between 125 mm in Baluchistan (South East) to 750 mm in the Northwest. Rainfall patterns are irregular. During July and August, the Sindh plains receive heavy precipitation. Some

regions, such as southern belt of Punjab and northern Sindh receive very low rainfall. The districts of Jhelum, Rawalpindi, and Attock, which lie above the salt range, get heavy amount of rainfall, that is, above 635 mm per year.[1]

Major groundwater resources of the country exist in the Indus Basin. The length of Indus Plain is 1,600 Km covering 21million hectares area. Natural precipitation is the major source of ground aquifer and also directly recharges to river flow. Water scarcity has increased in the last 90 years due to canals and watercourses seepage and losses during field application in the irrigated lands. The grounds aquifer of 38 MAF stands utilized against the prospective capacity of around 50 MAF. From the available 0.9 MAF ground water potential, 0.5 MAF is already being consumed with the available balance of0.4 MAF (Kahlown & Majeed, 2002).

Table 4

Water Availability in Large Reservoirs (MAF)

Reservoirs	Live Storage Capacity (Original)	Live Storage Loss (year 2025)
Tarbela	6.96 (1974)	4.16 (43%)
Mangla after raising	8.24 (2012)	1.16 (20%)
Chasma	0.72 (1971)	0.64 (78%)
Total	18.65	5.96 (37%)

Note. Source: Water Security Issues of Agriculture in Pakistan

The large reservoirs of Mangla on Jhelum River and Tarbela and Chashma on Indus River provide irrigation to main plains which comprise the breadbasket of the country. water retention is decreasing over the period. Against the world average of 40%, three major water arteries in Pakistan have less than 10% of annual inflow. The existing water potential is depleted by 0.2 MAF annually due to sedimentation in major reservoirs. The big dams have lost 35% of their storage ability and by 2025, it would increase to 37% (Qureshi & Ashraf, 2019). Pakistan has very limited water storage capacity.

[1] Ministry of Water Resources, *National Water Policy 2018* (Islamabad: Official Printers, 2002).

Distribution Mechanism

The water distribution system in Pakistan is also known as *warabandi.* In this method, water is distributed on rotational basis in proportion to the landholding of the farmers. The distribution of water is fixed by following a specific schedule with a particular duration of water supply according to the size of landholding of farmers of particular area.

The system of warabandi has resulted into low water productivity in Pakistan as farmers are required to consume water even when it is not required along with the traditional water courses into farms. This rigid and conventional water distribution system leads to low agricultural productivity. The tail end farmers also suffer from low water availability and water losses are huge till they reach at the end farms (Ali, 2015).The main reason for small farmers' plight is the collusion of irrigation officials and powerful farmers. The President of Sindh tail farmers' association reported that Sindh government has not released water to more than twenty waterways in Naseerabad for the last six months which has converted thousands of hectares in barren land (Siddiqui, 2010). There are two large sectors, which demand water in Pakistan. Table below shows the production pattern and requirement of water for cash crop to match food and economic self-sufficiency in grain basket. Pakistan has a well-developed irrigation system to support its agriculture. A considerable amount of water gets wasted in the lengthy water canals. The proper lining of water resources and telemetry system as per international best practices would save water losses. According to WAPDA report, the lining of major canals and 3.6 MAF could save more than 5 MAF by major water courses (Ahmed et al., 2007).

Table 5

Agricultural Water Demands (MAF)

Crops	1990	2000	2025
Wheat	26.27	28.8	56.91
Rice	18.78	22.24	16.68
Cotton	13.68	15.72	19.35
Sugar Cane	11.35	23.41	13.93
Other Crops	28.93	30.59	46.74
Total with Losses @70%	168.32	188.28	261.14

Note. Source: Development Advocate Pakistan. "Water Security in Pakistan: Issues and Challenges". Vol. 3, no. 4.

It is evident from increasing trend 46 m^3 per capita per annum of water demand that consumption patterns needed to be reviewed to be critically for the domestic users.

Table 6

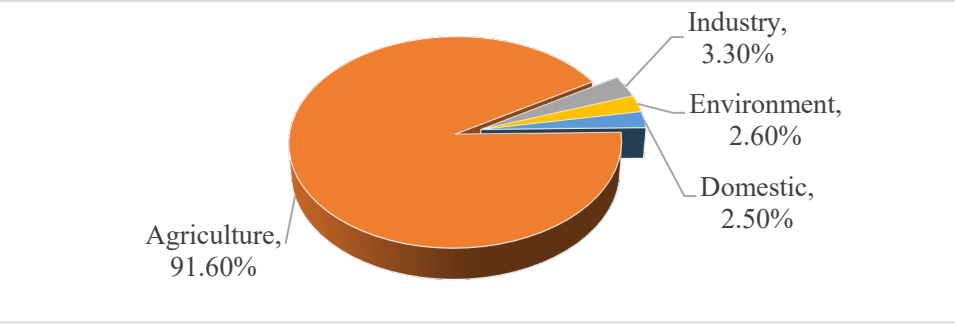
Water Demand for Domestic Use

Year	1990	2000	2025
Water Demand (MAF)	4.1	5.2	9.7

Note. Source: Development Advocate Pakistan. "Water Security in Pakistan: Issues and Challenges". Vol. 3, no. 4.

Figure 1

Water Use by Sub Sectors, 2016



Note. Source: Development Advocate Pakistan. "Water Security in Pakistan: Issues and Challenges". Vol. 3, no. 4.

From Water Sufficiency to Scarcity

According to the UN: "water scarcity refers to the scarcity in availability due to physical shortage, or due to the failure of institutions to ensure a regular supply or due to a lack of adequate infrastructure. Water scarcity has already affected every continent. Water usage has been increasing globally at more than twice the rate of population increases since the last century. An increasing number of regions are touching the threshold at which water services cannot be sustainably delivered, especially in arid regions" (United Nations Water, n.d.). Water stress occurs when the demand for water is over and above the water availability. The emerging water demand scenario over the next two decades is alarming (Qureshi, 2011).

Table 7

Water Demand Scenarios in Pakistan

Year	2015	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Description	Business as Usual Scenario			Moderate Demand Management Scenario		Strong Demand Management Scenario		Business as usual Scenario with Exceeded Extrapolation		Climate Change Scenario	
Industry	2.30	2.65	2.73	2.65	2.73	4.70	5.80	4.70	5.80	2.65	2.73
Municipalities	5.11	7.15	9.96	7.15	9.96	8.22	11.45	8.22	11.45	7.58	10.66
Agriculture	173.0	177.0	182.00	163.00	166.00	177.00	182.92	177.00	182.50	187.60	206.20
Total	180.4	186.8	194.69	172.80	178.69	189.92	200.17	189.92	199.75	197.83	219.59

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

Water Security: Economic Perspective

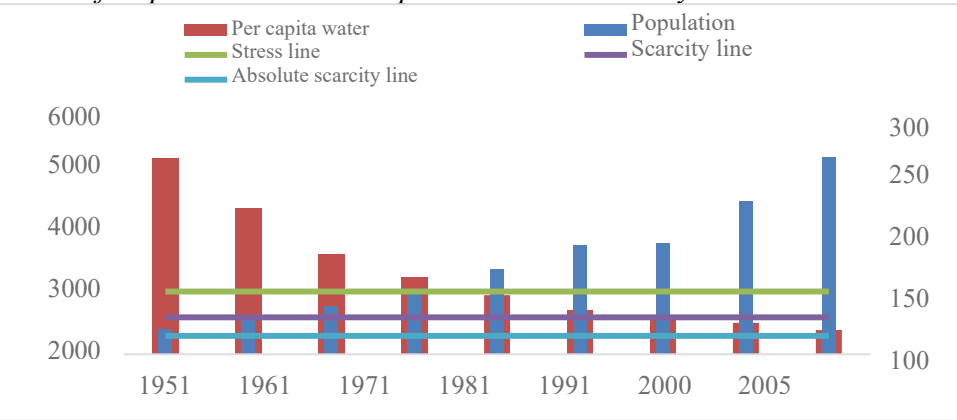
Physical water scarcity occurs due to the exceeding demand of the water availability. With the increase in population, the ratio of people affected by water scarcity is also expected to increase.

However, inefficient management of water resources and lack of water development infrastructure leads to economic water scarcity. Water access is the major constraint as sufficient water is available as potential to the harnessed/An excessive amount of water is available in the nature but its restricted accessibility is the major constraint. Economic water scarcity is also observed due to unregulated water use for agricultural and industrial sectors at the expense of domestic consumers (Petruzzello, 2023).

Pakistan is bestowed with natural water resources but suffers the most due to being the most highly populated country, lack of efficient water utilizations, and poor risk identification. Pakistan comprises three hydrologic units: the large surface rain water, ground water, and Indus Basin.

Figure 2

Trend of Population vs. Per Capita Water Availability



Note. Source. *Water Security Issues of Agriculture in Pakistan* (Islamabad: Pakistan Academy of Sciences, 2019).

Table 8

Per Capita Water-Availability in Different Countries (m^3)

Country	1955	1990	2025
China	4,597	2,427	1,818
Mexico	11,396	4,226	2,597
Philippines	13,507	5,173	3,072
Iraq	18,441	6,029	2,356
USA	14,934	9,913	7,695
Pakistan	2,490	1,672	837

Note. Source: Population Action International, 1993

In Pakistan, the current renewable water resource is 229 billion m^3 or around 1,100 m^3 per capita consisting of Indus Basin and outside water (Khoso et al., 2015). This shows that per capita availability of water is quite alarming in comparison with the international context.

Table 9

Distribution of Water for Different Purposes

S.#	Description	Purpose	Quantity
1	Human Need	Drinking	3to 5liters per capita per
		Household	200to 400liters per capita per day

S.#	Description	Purpose	Quantity
2	Irrigation	Irrigation water converted to vapor through biophysical process	2000to 5000liters per capita per day
3	Industrial Use	One automobile coming from assembly	Needs 300 liters of water
		Thermal conversion of each kilowatt hour energy generation	Needs 225 liters of water

Note. Source: Salim Khoso - An overview on emerging water scarcity in Pakistan

Policymakers should review the long-term water sustainability model critically in the context of water intensive practices (Khoso et al., 2015).

Water Resource Constraints and Challenges

Legal and Political Genesis of Water Politics

The British rulers, under "Radcliffe Award", demarcated the international border in the subcontinent. India, immediately suspended water supply to Pakistan after the partition, as six major rivers flow from India to Pakistan.

After a decade of stressed relationships between India and Pakistan, the World Bank arbitrated to resolve this issue. Both countries signed the Indus Water Treaty as a result of this meditation. The treaty allotted eastern rivers of Ravi, Bias, and Sutlej to India and the western rivers of Sindh, Jhelum, and Chenab were allotted to Pakistan. The conflict was resolved until 1999. However, the conflict started again when India started building Baglehar Dam on river Chenab. Pakistan has objections to the Wuller Barrage, Ratle, Swalkot dam, and Kishan Ganga, as flow of rivers Chenab and Jhelum would be hampered. Despite international arbitrations, the dispute still exists.

Pakistan not only faces water conflict with India but it also faces internal water conflicts and hydro politics. Water apportionment has been a major cause of conflict between provinces. The local water politics on water usage and apportionment. Moreover, the transboundary and national water conflicts also add to the water scarcity of the country.

Transboundary and National Water Conflicts

In 1948, after partition, India cut off water supplies to canals of Pakistan having head-works in eastern rivers of Ravi and Sutlej. This posed a serious threat to the economy and to the survival of Pakistan. Pakistan had to resolve this issue on top priority. As a result of exhaustive dialogues, Indus Water Treaty was signed between two states in 1960, the World Bank as a mediator. However, in the last two decades, Pakistan seriously objected the construction of hydropower stations on the western tributaries of Jhelum and Chenab.

Indus River Basin is considered as the economic "lifeline" of Pakistan. Despite such large irrigation system, all provinces have serious reservations and conflicts over the quantity of water being provided to their regions.

Sindh, Khyber-Pakhtunkhwa (KPK), and Baluchistan argue that Punjab uses their share of water by overconsuming it from river Indus and diverting it to irrigational tributaries for agricultural purposes. The irrigation projects once introduced by the British, in the late 1880s, automatically made west Punjab the breadbasket of Pakistan. Even today, Punjab plays a vital role for the food security of Pakistan and is also an industrial hub of the country.

In 1968, in order to review barrage water, reservoir discharges, and ground water usage viz-a-viz surface water, a committee namely the Water Allocations and Rates was constituted. The report of committee was submitted in 1970. Another committee under the supervision of Justice Fazl-e-Akbar was also formed to recommend river Indus apportionment but remained unable to conclude the process. Afterwards, a commission in 1977, comprising chief justices of the High Courts of all the provinces, headed by the Chief Justice of Pakistan was constituted to resolve the issue of provincial water apportionment. However, none of the recommendations could be implemented.[2] Finally, Indus Water Accord resolved the conflicts related to Indus water on 16th March 1991 in Karachi. Eventually, the Indus River System Authority (IRSA) was formed to monitor and review the distribution of water among the provinces (Siddiqui, 2010).

The accord addressed a number of challenges including water infrastructure, additional water management, and lost economic and employment opportunities. However, it lacked clear objective and had a

[2] Zakir Hussain,*Water resources in Indus Basin* (Lahore, 2014).

number of inherent flaws as well. No distinction has been observed between geographic limits of surface water or groundwater in Indus Basin. The accord also made no reference to water quality and to locations.

The accord was incoherent in itself since it explicitly allowed the provinces to reallocate water of an area. Moreover, it also allowed the provinces to develop water resources so that they could define its purpose for which water is used in its respective allocations. The accord also stated that adjusting allocations on pro rata basis would accommodate "shortages and surpluses". However, terms of shortages or surpluses have not been defined.[3] These inherent shortcomings in the accord created unrest among provinces pertaining to the issue of water apportionment. Major projects, such as, Kalabagh Dam have been on a halt due to these interprovincial differences. The accord has not been changed since it was signed in 1991 and a concerted effort is required to update it with emerging hydrological dimensions.

Resolution of Water Dispute: Indus Water Treaty

The water dispute between India and Pakistan was settled in 1960 by the World Bank under the name "Indus Water Treaty". In case of any conflict arising between two countries related to this treaty, the World Bank would have to play the role of arbitrator. The World Bank has the mandate to appoint a "neutral expert" when a stark difference arises among the countries and the Permanent body of Indus Commission. The neutral expert takes opinions from both sides and takes decision according to the principles mentioned in the treaty which is the fundamental law in case of interstate conflicts. In such situation, both parties have to accept the judgement given by the neutral expert. Still, in case of neutral expert's inability to resolve the clash among the parties, the difference is put up to the Court of Arbitration, stating it as a "dispute" (The World Bank, 1960).

Pakistan requested the World Bank to set up a Court of Arbitration to address its reservations and apprehensions pertaining to India's newly initiated hydroelectric power projects, that is, Kishanganga (330 megawatts) and Ratle. In turn, India requested that a neutral expert may be appointed to look into this matter. The World Bank encouraged both parties to mutually agree on a mechanism of redressal. The World Bank Group, Jim Yong Kim, the President, declared prior parties' consent for trial

[3] Arif A. Anwar, P.E., M.ASCE1 ; and Muhammad Tousif Bhatti

measures and its protection. The bank's announcement of holding the processes and to protect the treaty is in the benefit of both countries (Khoso et al., 2015).

Violations of the Indus Water Treaty and Implications

India has built Kishanganga Dam on Neelum River, whereas Pakistan raised objections on its height and capacity to hold water. Regardless of grave concerns raised by Pakistan on Kishanganga power project on Neelum River and Ratle Hydropower Project on Chenab, India is pursuing for the completion of these projects. India completed these projects in the course of 'paused' process of arbitration by the World Bank.

The Kishanganga Dam is a looming danger to Indus Basin as the water from Neelum river, upon entering into Azad Kashmir, would be diverted by India. India is also building a 23-kilometer passageway which would generate 330 MWs of electricity. This water would then be discharged into the Wullar Lake and eventually run through Jhelum River to Muzaffarabad. From Neelum-Jhelum hydroelectric project, 21% drop in Neelum River's inflow would reduce the forthcoming energy potential in Pakistan.[4]

In May 2018, amidst of other issues; Indian Prime Minister, Narendra Modi, initiated the Kishanganga hydropower project in state of Jammu & Kashmir (J&K) which caused another set of agitated rounds of objections by Pakistan. The Neelum-Jehlum project of Pakistan will eventually become impossible to be continued in the presence of Kishanganga project (Ahmad, 2018).

In middle of the tensions on held, India has begun water war and attempted to evade Indus Water Treaty. India has declined to convey flood information to Pakistan despite of repeated requests that was supposed to be provided according to the agreement of 1989 by the Commissioners of both countries. Pakistan's delegation had to go for a general tour of inspection to India in February, 2019 but it was intentionally delayed by India (Mustafa, 2019).

India has intended to construct more than 100 reservoirs with mini-micro and small hydroelectric projects on rivers under Pakistan's control during the previous years. If the plan materializes, it would badly affect

[4]Nosheen and Touheeda

Pakistan's interest both by triggering overflows and drying the waters of Chenab and Jhelum at high need times for Pakistan (Ahmad, 2018).

Political Disputes of Water Apportionment of Provinces

The consensus has been arrived after 20 years' negotiation and with a substantial grade of success. The members of IRSA have developed a formula to interpret the accord. According to this procedure, water is provided to the provinces, subject to the level of availability in the river system. However, provinces have their reservations about the water apportionment accord. According to Sindh, the dispersal of water to provinces should follow 10 days' schedule. Above all, Sindh blamed Punjab of "water theft" and stated that water theft of Taunsa and Guddu range is more than 16000 cusecs per week. Sindh raised the objection of non-receiving of water as per its prerogatives and clauses declared in the 1991 agreement. However, the current stream of water cannot cope with the minimum requirement. Two link canals, that is, Chashma-Jhelum (CJ) and Tonsa-Punjnad (TP) have been constructed on Indus River in order to provide water during the course of shortage of supply from Chenab and Jhelum rivers. Despite the availability of sufficient water in Jhelum and Chenab rivers, these canals remain functional even when there is water deficiency in Sindh. Sindh did not agree to it. Resultantly, the other three provinces receive more water than they are entitled for, whereas Sindh gets a reduced amount of water.

Conversely, Punjab considers that all sections of the consensus must be read and executed in concurrence with IRSA act. The accord was signed on the presumption that Sindh, after signing of accord, would not oppose the construction of Kalabagh Dam. However, unfortunately construction on the said reservoir could not be started due to political disputes pertaining to water apportionment. Punjab is the largest producer of agricultural resources of Pakistan, that is, 80%. The agriculture sector of Punjab engages more than 50% of the workers and brings home about 70% of export incomes. Punjab objects that the distribution be made on new requirements rather than following old water accord signed in 1991.

Baluchistan is of the view that even with exemption, it is bearing more losses than Sindh and Punjab. These losses occur due to the inundation of water in Kacha in Sindh and Punjab. The transparency of provincial record of accounts of discharges at canal heads is also questionable and, hence

Punjab and Sindh utilize these losses. Two link canals, namely, Chashma-Jehlum (C-J) link canal and Taunsa-Punjnad (T-P) link canal were created from Indus river in order to encounter water supply deficit. However, rules to operate these two canals have not been formulated till date. Baluchistan also objects that pertaining to defective irrigation canal system and infrastructure, Sindh is consuming more than its allotted water.

Khyber Pakhtunkhwa (KPK) raised the objection that the irrigation structure of Punjab is 150 years old and due to deficient transportation system, 50% of water is wasted before it reaches the area where it is required. Drainage system of the irrigation system is also old, thus creates twin problem of salinity and water logging (Khalid & Begum, 2020). The water provided in the post-accord period was much less than the water entitlements as per accord. The major problem in the implementation of accord is grievances of provinces on shortage of water availability as per their due shares.

Water Distribution Struggle between Federating Units

According to the Constitution of Pakistan, it is the federation, which shares powers both, between Provincial and Federal Governments. Water and Power Development Authority (WAPDA) is responsible to organize the multipurpose basins on the tributaries of Indus. Moreover, it is also responsible to control them with reference to Indus River System Authority (IRSA) and Provincial Irrigation Departments (PIDs) keeping in view the water shares and seasonal water apportionments to the provinces. Council of Common Interest (CCI), being the President as the head and Chief Ministers of the provinces with a parallel number of members from the Federal Government, is the supreme authority to address the complaints concerning water supplies from the natural sources, such as supply of water from rivers. In case IRSA cannot resolve the dispute, the only other forum is the CCI that resolves water-sharing disputes between the federation and provinces.

Kalabagh Dam: Political Settings

Water is the basic necessity of human life which ensures the availability of foodstuff and refines the value of life as well. Pakistan is facing a situation where quantity of water supply is decreasing and demand of fresh water is increasing. Resultantly, it is widening the gap between its

availability and demand. Therefore, it is mandatory to fill this gap by constructing additional water reservoirs/dams.

Kalabagh Dam is one such proposed project which can help to overcome the demand and supply gap of water in Pakistan. Kalabagh Dam (3600MW) is one of the proposed and largest dam of Pakistan. The place is situated downstream of Terbela barrage. An American consultant, M/s Tipton & Hill prepared the initial feasibility report for Kalabagh Dam project in 1956. M/s Chas T. Main in 1966 revised the same report and the project was included in the development portfolio of WAPDA. All steps regarding the feasible research for Kalabagh Dam including, exploration, financial viability, and environmental assessment have been completed. It was found to be practicable, worthwhile, and valuable by the international experts (Arif, 2010). No major project for water storage has been designed after the construction of Tarbela Dam in order to increase water storage capability for the improvement of agricultural capability of the country.

However, all provinces of Pakistan keep on getting entangled with each other over water distribution and construction of Kalabagh Dam except Punjab. Punjab is the sole supporter of the construction of Kalabagh Dam, whereas all other three provinces, Sindh, KPK, and Baluchistan are against this project owing to royalty and other linked issues. Sindh has serious concerns of low riparian rights and its environment hazards on Indus water. The provincial centric approach has halted the entire project and so far, Pakistan has failed to achieve consensus over the issue.

The Kalabagh Dam will be useful for the following four main objectives:

- 6.1 MAF additional storage presently flowing to Kotri Barrage,
- 2.4 million acres' area will be irrigated through canals,
- 3600 MW of power will be generated
- Flood water losses will be controlled.

However, Kalabagh Dam has been a controversial project and there is a provincial dispute over this project. The project could not be started on ground due to provincial disagreements. Pakistan, being a federation, has to obtain consensus from all provinces before starting any such project.

Provincial consensus is mandatory for making the project legitimate in a federation.

Sindh opposes the construction of the project; the primary objection raised by Sindh is that there is no extra water available for additional reservoirs. A technical committee was established by the Government of Pakistan to examine and assess the water availability. One more committee supervised by Senator Nisar A. Memon, worked individually and appraised the hydraulic data of WAPDA, IRSA, and irrigation departments. They stated that an additional amount of 35.2 MAF water is available underneath Kotri on annual basis.

KPK is of the view that 1000 miles' cultivable land in KPK would be immersed due to the erection of dam under environmental impact. Looming threat of flood would pose a serious risk for fertile plains and Nowshera city. The proposed site lies at Punjab KPK border, therefore payment of royalties of dam would also become a problem as per normal practice, originating province has the first right of dam royalties (Khalid & Begum, 2020).

The Federal Government states that the benefits of Kalabagh Dam's construction are significant. Due to sedimentation, the amount of water stored in Tarbela and Mangla Dam reservoirs is steadily declining. Along with substituting the loss of storage; Kalabagh Dam might also considerably increase the total amount of stored water and would also generate 3600 MW of cheap hydro-electricity. By storing peak flood flows, the dam may also support to control the effects of floods. Every year, flood water flows downstream of Kotri, which could be utilized for the economic development of the country (Ghazanfar, 2008).

Being a national and political issue, all the stake holders and individuals have the right to take a stance on the matter of construction of Kalabagh Dam. The technical feasibilities have been completed and there is no technical hitch in the project. The lack of consensus on the construction of this dam is not due to some technical reason but it is chiefly attributed to political opposition and dearth of trust. The project has been approved by the council of common interest (CCI) for two times.

Small Dams and Water Losses: Local Hydro Politics

Small dams are designed to store rainwater but often these dams do not provide desired results. A small dam was constructed in 2008 in Jhelum

with the storage margin of 1,655 acre-feet of water. Around 34,000 acres of land in Potohar was irrigated by only 54 small dams, which is nearly half of the 67,892 acres they are presumed to be irrigating but could not gather sufficient rainwater to let that stream in its waterway.[5]

Small dams are an important political tool to promise water availability with people, primarily because of their crops. However, around 80% of small barrages in Pakistan provide water to less than 50% of its intended capability. Major reasons behind under performance of these dams include:

- insufficient command area development,
- mechanical issues,
- dispersed inhabitants,
- dearth of experience in watered agriculture,
- and inadequate infrastructure.

Table 10

Flood Water Lost

Year	Volume of Flood water wasted to the sea in (MAF)
2010	55.0
2011	11.81
2014	23.46
Total	90.27

Note. Source: Ali (2015)

It has been estimated that 18 MAF of water from the hill torrents is wasted (The Water Sector Task Force of the Friends of Democratic Pakistan, 2012). The price of this lost water quantum is equivalent to 13.20 billion dollars which is equivalent to 10 Tarbela reservoirs and if routed through Kalabagh Dam, it would have generated more than 30,000MW of electricity, vital for the economic growth (Ali, 2015).

Due to underperformance of these small dams, their construction has been a contentious issue in Pakistan for a long time. Although, water is not the direct driver in local politics but it aggravates the already fragile social and economic stability in the context of local and regional politics. Water management is often used as an ethnic and communal divide pressure group

[5]Urban Unit (Punjab), *Water and Irrigation*, Technical Paper 8 (Lahore: World Bank, 2016), http://www.urbanunit.gov.pk/Upload/forest/8%20Water.pdf (accessed 6 September 2019).

politics use untapping of local water resources. Heavy reliance on supply side production brings in the inadequate water distribution amongst different sections. Rural dispossession is also linked with the water availability and water hostility as small farmers are on the edge of vulnerability (Mustafa et al., 2013). Government mostly relies on the big projects as the real project approach. The concentration of big dams along with the energy projects has been heavily focused in recent past leaving less room for tapping small hydro sites.

More than 60% of -water is misplaced within irrigation system and also effects the quality production to tail end farmers.

Table 11

Water Losses in Irrigation System

Location	Delivery at Head (MAF)	Losses (MAF)	Losses (%)
Canals	106	16	15
Distributary & Minor	90	6	7
Water courses	84	26	31
Fields	58	17	29
Crop Use	41		
Total		65	61

Note. Source: Water Security Issues of Agriculture

Water Development and Management Analysis

Indus Basin Water Resource Development: An Integral Option

The Indus civilization used watered farming, historically. Canal irrigation took place after the construction of the Upper Bari Doab Canal (UBDC) in 1859. Before that, irrigation was carried out through a system of flood canals, which provided water for Kharif (summer) crops and residual soil moisture for Rabi (winter) crops.

The development of canals continued after the construction UBDC. Sirhind Canal on Sutlej was constructed in 1872, then Lower Chenab on Chenab was constructed in 1892, and then Lower Jhelum on Jhelum in 1901 followed suit. In 1885 to 1914, Lower and Upper Swat, Kabul river and Paharpur Canals in Khyber Pakhtunkhwa were built. The Triple Canal Scheme, built in 1907 to 1915, connected the Ravi, Jhelum and Chenab, allowing Jhelum and Chenab extra water to go into Ravi. In 1933, The Sutlej

Valley Project was completed containing two canals and four dams. During the same period, the Sukkur barrage with seven canals scheme was also concluded. Thal Canal on Indus constructed in 1947 and Rangpur to Haveli from Trimmu Headworks on Chenab was built in 1939. Pakistan inherited this irrigation network in 1947. Division took place without taking in view the irrigated boundaries and later conflicts between two were resolved through the Indus Water Treaty in 1960.

After partition, on the Indus river Guddu, Kotri and Taunsa barrages were constructed. Pakistan has also built two large reservoirs namely Tarbela and Mangla. Tarbela dam started limited functioning in 1975-1976 and Mangla Dam Project was completed by 1968.

Pakistan has the world's largest contiguous irrigation system and comprises the Indus river and its branches with three huge dams. Indus system supplies water to main, branch canals and minor tributaries by regulation of flows, headworks and dams. More than 107000 waterways are channelized to the farms through the mogha system on the line tributaries which contribute to water losses. This system is designed on self-adjustment and water variation levels in the distributary canals. Indus River Basin contains more than 95 percent of irrigational network. In 2008, Total crop area of 21.20 million hectares of Pakistan has more than 95% in Indus plain i.e. 19.99 million hectares (Frenken, 2012).

Water Vulnerability Analysis: A Progressive Threat

Altering forms of monsoon rain, winter rainfall, snow, and ice thawing due to climate change are leading towards varying availability of water in Pakistan. These changes in physical features affect the water availability. The scheme "Vulnerability of Pakistan's Water Sector to the Impacts of Climate Change" was started to address this breach in July 2015.

Table 12

Water Scarcity Index

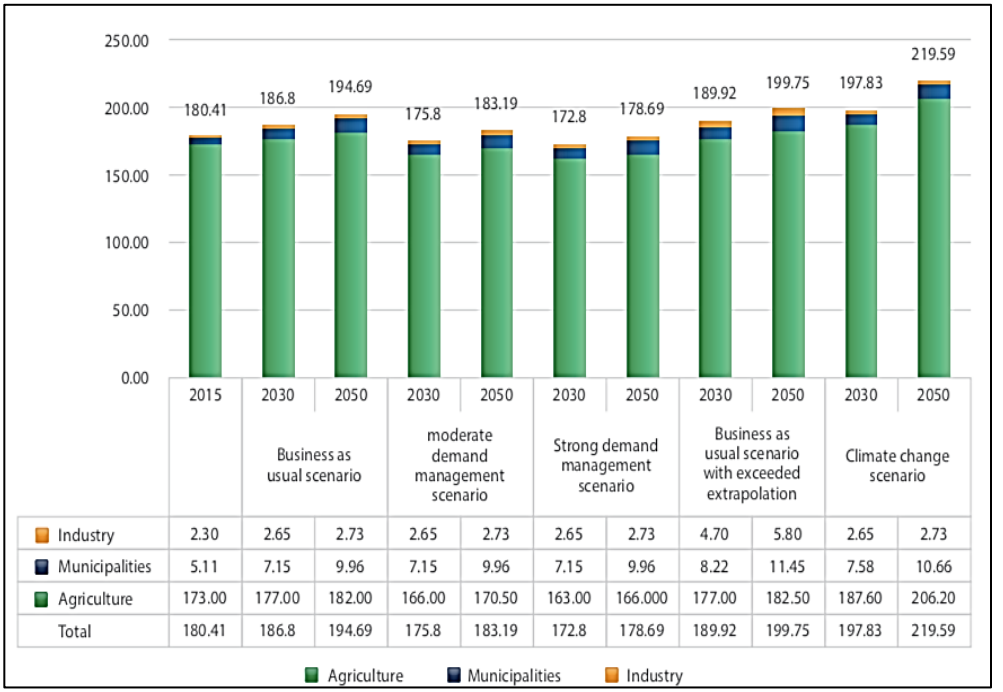
	Renewable fresh water availability per capita in m^3/year	Classification
1.	> 1700	Limited Stress
2.	1000-1700	Water Stressed
3.	500-100	Water Scarce
4.	<500	Absolute Scarcity

Note. Source: Undeclared water war on Pakistan, Prof. Dr. Iqbal Ali

Pakistan has already reached at the level of desert nations of Ethiopia, Algeria, and Libya. This situation can only be avoided if series of dams are built on the floods of Indus system (Mustafa et al., 2013).

Figure 3

Water Demands with Variability Matrix



	2015	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
		Business as usual scenario		moderate demand management scenario		Strong demand management scenario		Business as usual scenario with exceeded extrapolation		Climate change scenario	
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

Note. Source: Qureshi (2011).

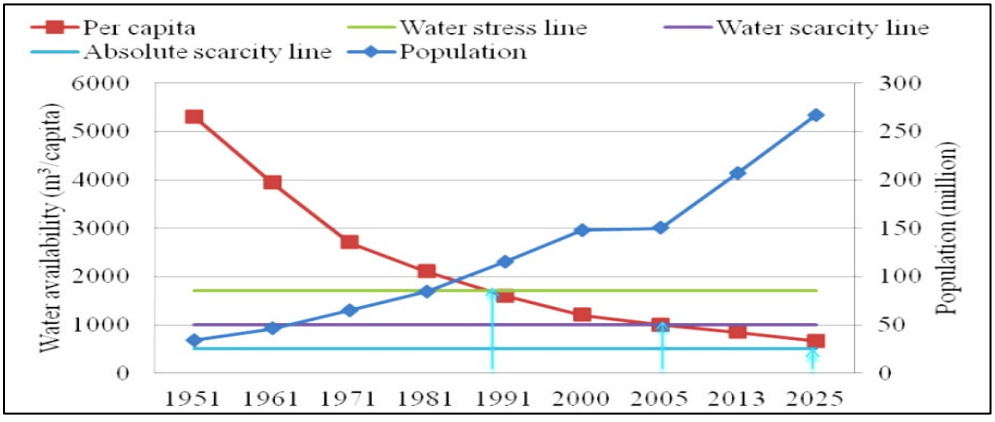
Agriculture in Pakistan is mainly based on the availability of water in the irrigation system. Indus Basin is richly blessed with water resources but a variable climate and hydrology has challenged the agricultural production within this region. The inadequate and old infrastructure of Indus Basin with limited water storage capacity due to few reservoirs and the increasing sedimentation of existing reservoirs is a challenge to agricultural sector. There are many inefficiencies at the canal, watercourses, and field levels. Low water prices do not generate adequate funds to cover the existing operations and maintenance costs. Pakistan is also experiencing a decline in per capita water availability as its population is increasing at a rapid pace. In order to meet the food requirements of an expanding population, water demands in the agriculture sector are expected to increase at higher level.

Climate change and climate shift are among other challenges to the in-time water availability in required quantities. The water availability for agriculture sector is expected to be affected by rise in mean temperatures, changing precipitation patterns, and by weather abnormalities, such as floods and droughts.

Water vulnerability in the next few decades is going to reach at an alarming level with different variables and analysis patterns. Factors, such as temperature, humidity, extreme events, and change in rainfall patterns are likely to influence water utilization. Climate change coupled with climate shift and poor socio-economic conditions could further deteriorate water quality and quantity. This could rapidly increase the number of people exposed to a high risk of water pollution, leading to water borne diseases and human health issues. Moreover, deteriorated water quality would also reduce the quantity of water available for personal use. These processes would likely compound Pakistan's future water demand challenges along with population expansion and economic growth.[6]

Figure 4

Progressive Water Consumption Pattern



Note. Source: Pakistan Council of Research in Water Resources

Water scarcity by 2025 per capita would significantly fall below 1000 cubic meter per capita.[7] The situation of water scarcity has implications for Pakistan's energy sector. In Pakistan, energy access remains a significant

[6] Pakistan Council of Research in Water Resources
[7] Pakistan Council of Research in Water Resources

concern as the country faces power outages and rotational load shedding. However, changes in water supply are unlikely to affect the current developments of thermal power plants. On the other hand, Pakistan has a significant potential in hydropower development and is also interested in facilitating private sector to invest in hydropower generation. The matter of fact is that the hydropower generation is not only affected by climatic changes but also by water stress. The hydroelectric generation capacities could potentially be affected by expected lifespan of newly constructed dams and the loss of glaciers beyond the middle of this century and their impacts on water flows in the Indus River (United Nations Development Program [UNDP], 2016).

National Water Policy 2018: Capacity Building Strategy vs. Implementation Gaps

The absence of consensus based and inclusive approach centric water policy has been worsening the water crisis since many decades.

Recently, the Council of Common Interests (CCI) ratified The National Water Policy (NWP) on 24th of April, 2018, with agreement of federating units. NWP would enhance the developmental resources from 3.7% to 10% by the end of 2030. According to National Climate Change Policy 2012, water pricing at delivery points, strategic initiatives, and selection of water development reservoirs along with sea intrusion would be prioritized on development agenda of the provinces. Water rights with ecological benefits for all regions would be secured. This policy would also address the issues related to adopting an intervention for large storage development like 14 million-acre feet (MAF) by immediately undertaking 6.4 MAF Diamer-Bhasha Dam. This initiative would also help to cut down water loss from 30 to 33% through better technological irrigation system and water pricing mechanisms. The National Water Policy 2018, is an Integrated Water Resource Management (IWRM) Policy that outlines interventions by the central government and the provinces.

The policy had input from all the stakeholders; it was formulated after getting recommendations of the Climate Change Division. Therefore, the policy had to counter adverse effects of the most contentious issue of climate change. It also emphasized to build larger and smaller dams in order to increase water storage capacity. It is not only limited to build new

structures but it also focuses on the rehabilitation of the existing water infrastructure and regulating the excessive abstraction of groundwater.

Supply side issues always received considerable attention but demand side issues of water availability were largely ignored. This policy also addresses demand side issues. It does so by reducing the demands of water user sectors, especially agriculture by strengthening the capacities of federal and provincial water resource development and management institutions.

The National Water Policy recommends to explore regional mechanisms for addressing Pakistan's increasing risk to water-related calamities due to transboundary water discharges and stoppages. Moreover, the policy also suggests to conduct a research to assess the effect of developments of the western rivers by India. These include impacts for energy generation, food production, and environment protection by conforming to International water laws and Indus Water Treaty.

However, it does not cover capacity building, that is, an institutional mechanism for water sector which is the clear implementation gap as no effective institutional mechanism was envisaged to plug the gaps of existing water sector institutions.

Integrated Water Management: Production vs. Conservation Model

The concept of Integrated Water Resources Management (IWRM), defined by GWP (Global Water Partnership) is "A process which promotes the coordinated development and management of water, land, and related resources. It intends to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems".

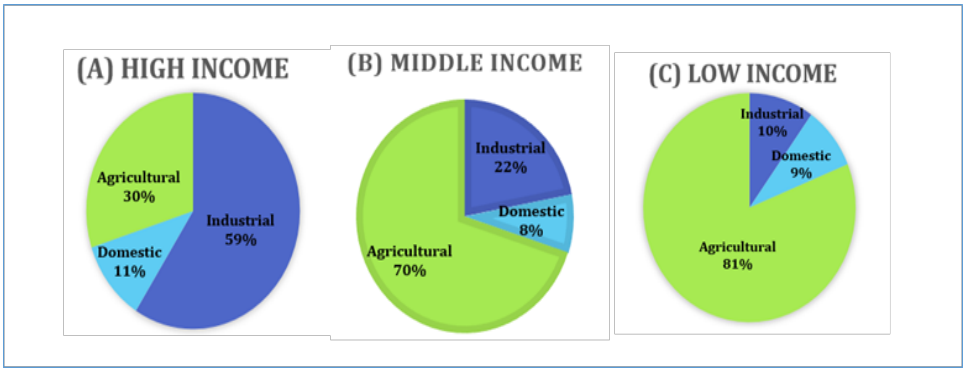
It is an approach which takes into account all the sectors affecting water demand and supply. It recognizes that water resources are an integral component of a natural resource, a social and economic good, and ecosystem. They are designed to replace the traditional methodology of water management. IWRM is the practice to take decisions with correct actions while considering multiple options.

The water requirement of Pakistan in future would be significantly higher than the available quantity of water. In order to fulfill the increasing water requirements, water losses must be minimized from water supply

systems by adapting an efficient irrigation system and building water reservoirs on prospective locations. The adoption of artificial ground water refresh methods to integrate the rain and spare flood water with the aim to supplement the diminishing water aquifers is a critical factor.

Figure 5

Competing Water Uses for High and Low Income Countries



Note. Source: Undeclared water war on Pakistan, Prof. Dr. Iqbal Ali

The right sectoral use of water is linked with income of the countries. Apart from this, the trend of different sectors on above validates that gradual balance between agriculture and industrial sector for water consumption would lead towards economic sustainability.

The above figure suggests that water losses in agriculture sector require immediate integrated water irrigation management to replace the age-old water courses and the overall losses to agriculture and economy.

This integrated approach emphasizes on the coordinated decision-making pertaining to water related issues. It also challenges the traditional, disjointed water development and management techniques. The climatic, demographic, and economic changes have evolved the hydrological regime which, in turn, has serious consequences for people and their environment. IWRM systems must be responsive to change and adaptation of new economic, social, and environmental conditions including human values. IWRM focuses on efficiency and equity in the distribution of water and ecological sustainability, to safeguard the ecosystems. The National Water Policy 2018 is based on this very approach of IWRM.

Politically Exclusive Water Governance Framework-The Sufficiency Factor

Water security refers to the availability of suitable amount of water in qualitative and quantitative terms including tolerable levels of risks to human health, economy, and ecosystems. Water governance is defined as "through which range of organizations and administrative processes are defined, community interest is safeguarded, and water availability is ensured." The inclusion of physical and social variables as well as multiple scales of different stakeholders making shared analytical decisions in context of water related tradeoffs and water conflicts.

It imperative to make the water governance free of political interventions, since distribution of water on political influence and exploitation of water resources based on political influence cause discontentment among the provinces and strengthened the hydro politics at regional level.

The National Water Policy 2018 provides a politically exclusive framework for governance of water resources in Pakistan. According to the policy, the federal government plays a principle role in the governance of water capitals to ensure their sustainable and efficient utilization. The guiding principles of equity and participatory decision-making would spread the benefits and advantages on central and provincial level for better governance. [8]

Politically Exclusive Water Governance model is as crucial as water security and its long-term sustainability is the real challenge. Water governance can be defined as a governance in which interests of communities are articulated and implemented. Moreover, in water governance, public policymakers are held accountable to formulate water policies and implement water services. The traditional command and control approach may be reviewed by exploring the integrated solutions for the complex problems. The multi-governance level and polycentric of water usage is the preferred option for highly populated countries. UNECE in 1992 convention, on water sources in different countries, viewed water security issues and principles of its management and its need for the cooperation (Bakker & Morinville, 2013). It is directly linked with

[8] Ministry of Water Resources, *National Water Policy 2018* (Islamabad: Official Printers, 2018).

multilevel governance of water which is necessary for the new conceptual framework and local hydro trap politics. Multiple scale and layered water approaches would open new and important avenues. The risk of inadequacy at local planning with new governance structure is an important area to be addressed immediately.

In Pakistan, water politics is linked with the constituency voting, social power, and social status. Therefore, an equitable water access for each citizen and state-dominated water governance would create a level playing field for water power imbalances. Moreover, local expertise needs to be involved for better regulatory regime as well. This local inclusion would help to meet local conditions, shift from water dominated politics to water sustained society, and economy.

On Federal Government level, regulatory standards, water apportionment, and larger resource production should be managed efficiently. However, specific functions, such as small dam infrastructure recycling and reuse of water, restrictions on demands, and low flow target limits must be delegated at district levels. Whereas, sub-district levels should be dealt with active involvement of farmers and local community.

Strategic Water Management Intervention for Sustainable Economic Growth

Water is a necessary element for the development and flourishment of agriculture sector in Pakistan and across the globe. Pakistan is an agrarian economy and it is imperative that in order to obtain sustainable economic growth in agriculture, Small and Medium Farmer Growth Strategy may be formulated. Small farmers should be facilitated by providing them access over quality inputs, including irrigation water, by developing an institutional mechanism. In order to increase water use efficiency in the prevailing scenario of water scarcity in the country, the farmers should also be given access over latest technologies. For this purpose, Small Farmer Development Corporations (SFDCs) could be developed in all provinces. The aim of SFDCs is to provide on farm water management and drip irrigation services in integrated manners.

In the world, Pakistan is the 3rd largest groundwater consumer accounting for 5.2-million-hectare area under groundwater irrigation (4.6 percent of the global groundwater-fed cropland) with 9% of the global groundwater withdrawals. The reliance on groundwater has reached up to

70% in a number of canal water deficient areas mainly due to the diminishing surface water supplies. In order to cope with this dilemma, an inclusive plan for water infrastructure, management practices, and rehabilitation is an urgent requirement. Additionally for the sustainability of irrigated farmlands, its current capacity to store 15% of annual river flow is far less than required. Therefore, construction of large dams is imperative for sustainable national economic growth. Pakistan has plentiful hydroelectric prospects of around 100,000 MW through construction of dams and reservoirs. The accelerated development of hydro power projects would ensure economic growth along with the production of ample and environment friendly energy and simultaneously addressing the irrigation storage. Thus, water management as a policy option for the sustainable economic growth is imperative and a prerequisite for the economic development of the country (Hussain, 2017).

Conclusion

Pakistan stands as a front-liner nation, severely impacted by water scarcity and heavily relies on the water-based economy. The spectrum of its vulnerability demands an urgent water management policy intervention to improve water management practices over the available water resources. The infrastructure implementation along with the integrated water management policies based on short; medium, and long-term basis would help to mitigate the looming water shortage challenge.

An integrated approach is needed for the Indus Basin to ensure the sustainable use of water by promoting a holistic, coordinated, and participatory approach assessment for each province. This would impact water stress and establish a clear link with water availability.

Water rights and water policies need to be assessed critically along with the legal framework after consulting with provinces. Water resources are heavily stressed due to population growth, elite capture of water resources, rapid urbanization, unjust distribution of water amongst provinces, and shifts in water consumption patterns. Local water resources and tapping of torrential water need to be captured immediately with its judicious distribution to small farmers.

Water management and water security nexus would empower and engage all the water stakeholders from the top to the grass root level.. Addressing potential threats pertaining to mismanagement of water

resources alongside harnessing the water resource development would lead Pakistan to sustainable socio-economic development.

Recommendations

The development of new water reservoirs is essential for economic sustainability of the country. Moreover, future water planning should be based on the Indus Basin as a vital developmental option. Modern techniques for the development of water resources may also be explored. For instance, the development of rainwater resources, tapping potential of hill torrents, and small dams in the Suleiman range in Baluchistan and Potohar region in Punjab. The construction of small dams as a parallel option needs to be highly prioritized to tap the torrential and monsoon water opportunities and flood losses. The building of medium and small sized dams would renew the local water aquifers and help to boost the local economic conditions as the parallel option of Kalabagh and Diamer Bhasha Dam.

Water vulnerability mechanism augmentation with a central water database and repository should be developed for equitable water apportionment to provinces and to expand early warning system of floods and droughts.

The distribution and allocation of water must be ensured in an equitable and accountable manner without any political influences. The role of Council of Common Interest may be augmented to resolve water allocation disputes between provinces under IRSA Act; and it may be used as a binding instrument for all provinces.

An Integrated Water Governance model in politically exclusive environment ought to be immediately placed in operation. This model would harness the optimum potential of water resources available and its effective distribution of the system along with the water conservation strategy. The local hydro politics regime should be discouraged with inclusive models.

References

Ahmad, O. (2018, June 15). The Indus waters treaty: Caught between a dispute and a hard place. *The Third Pole.* https://www.thethirdpole.net/en/energy/indus-water-treaty-dispute/

Ahmed, A., Iftikhar, H., & Chaudhry, G. M. (2007). Water resources and conservation strategy of Pakistan. *The Pakistan Development Review*, *46*(4), 997–1009. https://doi.org/10.30541/v46i4IIpp.997-1009

Ali, I. (2015). *Undeclared water war on Pakistan: Tactical and strategic defence measures*. Allied Book Company.

Arif, K. M. (2010). *Estranged Neighbours: India, Pakistan, 1947-2010*. Dost Publications.

Ashraf, M. (2018). Water scarcity in Pakistan issues and options. *Hilal*. https://pcrwr.gov.pk/wp-content/uploads/2021/07/Water-Scarcity-in-Pakistan-Issues-and-Options-May-18.pdf

Bakker, K., & Morinville, C. (2013). The governance dimensions of water security: A review. *Philosophical Transactions of the Royal Society A*, *371*(2002). https://doi.org/10.1098/rsta.2013.0116

Cincotta, R. P., Engelman, R., & Anastasion, D. (2003). *The security demographic: Population and civil conflict after the Cold War*. Defense Technical Information Center. https://apps.dtic.mil/sti/citations/ADA422694

Frenken, K. (2012). *Irrigation in southern and eastern Asia in figures: AQUASTAT survey-2011* (Water Reports No. 37). Food and Agriculture Organization of the United Nations (FAO). https://www.cabdirect.org/cabdirect/abstract/20123323059

Ghazanfar, M. (2008). Kalabagh Dam and the water debate in Pakistan. *Lahore Journal of Policy Studies*, *2*(1), 153–180.

Government of Pakistan. (2012). *National climate change policy*. https://mocc.gov.pk/SiteImage/Policy/NCCP%20Report.pdf

Government of Pakistan. (2016). *Water and irrigation* (Technical Paper No. 8). https://pbit.punjab.gov.pk/system/files/8.%20Water.pdf

Hashmi, F. K., Rashid, M., Razzaq, A., & Hussain, A. (n. d.). *Integrated water resource management (IWRM) & its impact on agriculture in Pakistan*. Zarai Taraqiati Bank Limited. https://www.ztbl.com.pk/wp-content/uploads/Documents/Publications/Research-Studies/IntgrWaterResMgt.pdf

Hassan, M. (2016). Water security in Pakistan: Issues and challenges. *Development Advocate Pakistan*, *3*(4), 1–34.

Hussain, Z. (2014). *Water resources in Indus Basin.* Al-Faisal Publisher

Kahlown, M. A., & Majeed, A. (2002). Water resources situation in Pakistan: Challenges and future strategies. *Science Vision*, *7*(3/4), 46–49.

Khalid, I., & Begum, I. (2020). Hydro politics in Pakistan: Perceptions and misperceptions. *South Asian Studies*, *28*(1), 7–23.

Khoso, S., Wagan, F. H., Tunio, A. H., & Ansari, A. A. (2015). An overview on emerging water scarcity in Pakistan, its causes, impacts and remedial measures. *Journal of Applied Engineering Science*, *13*(1), 35–44. https://doi.org/10.5937/jaes13-6445

Mustafa, D., Akhter, M., & Nasrallah, N. (2013). *Understanding Pakistan's water-security nexus*. United States Institute of Peace. https://www.usip.org/sites/default/files/PW88_Understanding-Pakistan's-Water-Security-Nexus.pdf

Mustafa, K. (2019, August 20). Deviation by India from Indus waters treaty worrisome: Vawda. *The News International.* https://www.thenews.com.pk/print/514579-deviation-by-india-from-indus-waters-treaty-worrisome-vawda

Nabi, S., & Batool, S. S. (2022, October 7). India's dams and Pakistan's water crisis. *The Diplomat*. https://thediplomat.com/2022/10/indias-dams-and-pakistans-water-crisis/

Petruzzello, M. (2023, April 19). *Water scarcity*. *Encyclopedia Britannica*. https://www.britannica.com/topic/water-scarcity

Qureshi, A. S. (2011). Water management in the Indus basin in Pakistan: Challenges and opportunities. *Mountain Research and Development*, *31*(3), 252–260. https://doi.org/10.1659/MRD-JOURNAL-D-11-00019.1

Qureshi, R., & Ashraf, M. (2019). *Water security issues of agriculture in Pakistan*. Pakistan Academy of Science. https://www.paspk.org/wp-content/uploads/2019/06/PAS-Water-Security-Issues.pdf

Sherani, S. (2019). Institutional reforms in Pakistan: Missing piece of the development puzzle. In S. S. Aneel, U. T. Haroon, I. Niazi (Eds.), *70 years of development: The way forward* (pp. 39–61). Sang-e-Meel Publishers. https://www.sdpi.org/sdpiweb/publications/files/Seventy-Years-of-Development-The-Way-Forward.pdf

Siddiqui, I. H. (2010). *Hydro Politics & Water Wars in South Asia*. Vanguard Books.

The Water Sector Task Force of the Friends of Democratic Pakistan. (2012). *A productive and water-secure Pakistan*. https://mowr.gov.pk/SiteImage/Misc/files/FoDP-WSTF-Report-Final-09-29-12.pdf

The World Bank. (1960). Indus water treaty. *World Affairs*, *123*(4), 99–101. http://www.jstor.org/stable/20669916

United Nations Development Program. (2016). *The vulnerability of Pakistan's water sector to the impacts of climate change: Identification of gaps and recommendation for action*. https://www.undp.org/pakistan/publications/vulnerability-pakistan%E2%80%99s-water-sector-impacts-climate-change-identification-gaps-and-recommendations-action

United Nations Water. (n. d.). Water Scarcity. https://www.unwater.org/water-facts/water-scarcity