PAKISTAN ENGINEERING CONGRESS

Established: 1912

WORLD WATER DAY 2021

ON THE THEME OF

"VALUING WATER"

VOLUME 17

MARCH 2021 LAHORE

ON BEHALF OF
PAKISTAN ENGINEERING CONGRESS

The Pakistan Engineering Congress as a body does not hold itself responsible for the opinions expressed by different authors in this Volume.

Compiled and Edited

By

Engr. Husnain Ahmad
Past President / Convener Symposium Committee

Published

By

Engr. Syed Nafasat Raza
Secretary Pakistan Engineering Congress

Price Rs. 500/-

Members – Free

Can be had at
PAKISTAN ENGINEERING CONGRESS
(4th Floor) Pakistan Engineering Congress Building,
97-A/D-1, Liberty Market Gulberg-III, Lahore 54660
(Near Liberty Roundabout)
Phone: 042-35784238, 042-35784235 Fax : 042-35784236
Web-site: www.pecongress.org.pk
E.mail : info@pecongress.org.pk
ISBN: 978-969-603-046-1

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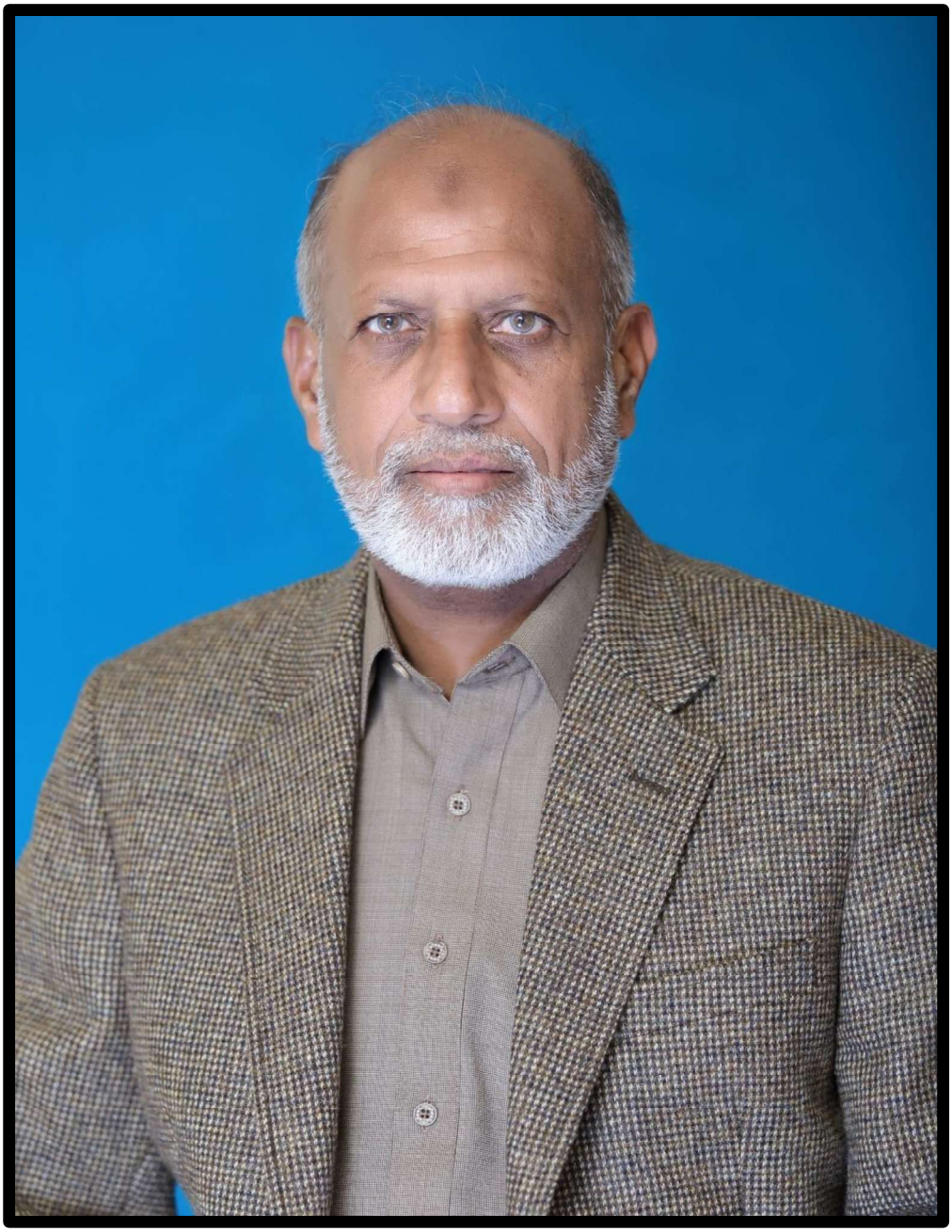
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Address of Welcome
By
Engr. Amjad Saeed

President
Pakistan Engineering Congress

Welcome Address
By
Engr. Amjad Saeed
President Pakistan Engineering Congress
On World Water Day, 2021
On the theme of "Valuing Water"

The Honorable
Mr. Muhammad Mohsin Leghari,
Minister for Irrigation, Punjab,
Distinguished Guests & the team representing WWF,
Members of Pakistan Engineering Congress,

Assalam-o-Alaikum and Good Morning!

Pakistan Engineering Congress is celebrating World Water Day every year since 2005 on the Themes announced by UN-Water. It is not less than Iconic that since then 171-Technical Papers on different Water related Topics have been presented from the Congress Forum. These papers were documented in the shape of 16-Volumes and distributed complimentarily to Members of Congress, Libraries, Educationists, Water Resources Experts, Concerned Provincial and Federal Government Departments and have been up-loaded on Congress Web site www.pecongress.org.pk, as well.

Ladies & Gentlemen!

This year the theme of World Water Day is "Valuing Water". Pakistan Engineering Congress in collaborative with WWF has assembled a galaxy of eminent Water specialists who will be presenting their proposals on the theme of "Valuing Water" and pertinent relevant issues.

Ladies & Gentlemen!

At the time of construction of Mangla Dam and Tarbela Dam, the then World Bank President observed that Pakistan is destined to put in place One Mega Dam every decade. If this sane advice had been implemented 3-4 Multi-purpose

reservoirs would have been under operation leading to abundant water availability contributing to robust agriculture, cheap electricity generation and industrial advancement. However, due to gross indifference and ill planning, the country is faced with Power & Water shortage and consequent economic slowdown.

Ladies and Gentlemen!

In 2016, PCRWR reported that Pakistan touched the "Water stress line" in 1990 and crossed the "Water scarcity line" in 2005. The agriculture sector according to the Economic Survey of Pakistan contributes about 20% to the total GDP and also provides employment almost to a half of total population of Pakistan. Similarly, the majority of Pakistan's export goods rely on agriculture. About 70% of the export goods are agriculture products. This means that agriculture is the backbone of country's economy. But the agriculture sector is dependent on water (consumes 90% of Water). Thus, the water scarcity results in severe economic distress to country's economy. But merely due to the lack of poor concepts on valuing the water, the water having an economic value of about $ 70 Billion is being thrown into the sea every year in a water starved country.

Ladies and Gentlemen!

Decades have gone by but the country has failed to tackle the Hill Torrents "that are without any tree cover/vegetation, upon rains, the water gushes, out through over flowing Nullah's destroying everything in the path property, homes etc. The rain water drained out by Hill Torrents can be stored in 1200 well identified Spaces i.e. Mini Water Reservoirs / Tanks and used in brining 1.409 MAF additional land under cultivation. Besides harnessing hill Torrents, there is dyer need to develop.

Ladies and Gentlemen!

Numerous countries are also tapping other sources of storage and preservations of water:

- Harvesting Rainwater.

- Underground Water storages to store rainwater and minimize urban flooding.
- Waste water utilization after treatment is unavoidable for Food & Fiber Security and to meet the demands of increasing population.
- Saving Water ways from Industrial effluent and domestic wastewater

Thanks.

-: Pakistan Paindabad :-

Paper No.172

ENHANCING VALUE OF PAKISTAN WATER IN THE CONTEXT OF UNITED NATIONS SUSTAINABLE DEVELOPMENT GOAL (SDG 6)

Riaz Nazir Tarar

ENHANCING VALUE OF PAKISTAN WATER IN THE CONTEXT OF UNITED NATIONS SUSTAINABLE DEVELOPMENT GOAL (SDG-6)

By

Riaz Nazir Tarar[1]

FOREWARD

With rapidly growing population and considering all renewable water resources, Pakistani per capita water availability has now reduced to the level of about 1100 m^3 against 6000 m^3 in 1960. Thus, Pakistan is now knocking at the door of 'acute water scarcity'. The position is further exacerbating with global warming as the country is now ranked as fifth frontline country of the world prone to adverse impacts of climate change. This naturally raises worrying water security issues which, in the long term, may endanger Pakistan's economic growth with dire consequences.

During 2019, World Bank issued a report titled 'Pakistan – Getting More From Water'. This examined in depth the water security issues in the context of: current situation; undermining factors; proper understanding of water issues; historic availability and its utilization in the bread basket of Indus Basin; interventions for improvement; and development constraints in the time horizon upto 2047, 100 years after its creation in 1947. Based on state-of-art economic modelling the report proposes 'Way Forward' to help in economic growth of Pakistan for having a place among 'Upper Middle Income States' of the World by 2047.

On the basis of findings and recommendation of this thought provoking World Bank Report, this paper attempts to bring into focus the gravity of situation with business as usual (BAU) water resources development and management. Hopefully, it may help the policy decision makers, engineering fraternity, intelligentia and public at large in awaking from the apathy and inaction before it is too late.

1. INTRODUCTION

Over 4,000-year-old Indus Civilization has its roots in irrigated agriculture. Pakistan still relies heavily on the Indus River System for water supply to all sectors of economy as well as for energy generation. Water for irrigation across semi-arid Indus Plain, which underpins national food security, is the dominant use.

Pakistan is home to about 222 million people (2018 census) a near seven-fold increase since independence in 1947. In 1960, after almost a decade of tripartite negotiations under aegis of the World Bank, Indus Waters Treaty (IWT) was signed by India and Pakistan. IWT formalized a partitioning of the Indus Basin water resources between Pakistan and India as well as defined basic water resource envelope for Pakistan. Although blessed with sizeable water endowment, along

[1] *General Manager (R) WAPDA & Associate, National Development Consultants (NDC), Lahore*

with extensive glacier storage that buffers supply variations, huge increase in population is now challenged by relative (per capita) water scarcity. On the other hand, population and water demands are projected to grow for several decades. This challenge of balancing supply and demand will be further exacerbated by climate change. It will increase variability in supply and, because of higher temperatures, push water demands even higher. These challenges are also vexed by widespread pollution that is degrading the resource base and undermining both public and environmental health.

Pakistan cannot continue business as usual (BAU) water management. How Pakistan tackles these challenges, and the speed at which it does so, will have a major influence on country's rate of economic development and quality of life for its peoples? While there are major infrastructure and financing challenges to surmount, fundamental challenge is of governance in irrigation and urban water supply at federal, provincial, and local levels.

2. WATER SECURITY ISSUES

i. Current Water Security Situation.
ii. Water Security Undermining Factors.
iii. Proper Understanding of Water Resources.
iv. Historic Water Availability and its Utilization in Indus Basin Irrigation System.
v. Interventions for Improving Water Security.
vi. Water Security and its Developmental Constraints (after 100 years (2047) of creation of Pakistan in (1947).

2.1. CURRENT WATER SECURITY SITUATION

Water security describes social, economic and environmental outcomes beneficial and detrimental from how water is managed and used?

Universal 'Water Security Diagnostic Framework' is shown in Fig. 1.



Figure 1: Water Security Diagnostic Framework

Pakistan is endowed with sizeable water resource because only 16 countries of the World have more water. However, being world's sixth most populous country, its water availability per capita is comparatively low. Fewer than 10 percent of global population is now living in countries with less per capita water availability. Water scarcity is challenging but does not define a country's economic destiny. There are 32 countries with less water per capita than Pakistan but across these countries, average per capita gross domestic product (GDP) is 10 times that of Pakistan. Only six of these 32 water scarce countries are poorer than Pakistan including all African nations with little irrigation investment and a heavy reliance on traditional rainfed agriculture.

In Pakistan, water use is heavily dominated by agriculture, which contributes around one-fifth of national GDP, but less than half of this is from irrigated cropping. Irrigation contributes around US$22 billion to annual GDP. Four major crops (wheat, rice, sugarcane, and cotton) that represent nearly 80 percent of all water use generate less than 5 percent of GDP around US$14 billion per year. Other economic contributions from water are difficult to accurately assess, but hydropower generation is economically significant with a current annual between 1 to 2 billion US$.

Economic costs to Pakistan from poor water management including floods and droughts are conservatively estimated to be 4 percent of GDP, or around US$12 billion per year. Economic costs of pollution and other environmental degradation have not been assessed. These estimates of economic benefits and costs cannot be directly compared or aggregated, but they demonstrate that Pakistan gets a poor economic return from its significant water resource.

However, for many Pakistanis, poor social outcomes from water best characterize water insecurity. Waterborne diseases are a leading cause of suffering and death in Pakistan, reflecting widespread contamination of water supplies by sewage effluent. Poor water supply, sanitation and hygiene contribute to high levels of childhood stunting, undermining human capital, especially in rural areas where sanitation is particularly inadequate and most water supplies are contaminated. Up to a quarter of the population may be at risk from arsenic contamination of drinking water. Floods and droughts also have significant social impacts, again affecting women and children the most.

Scant attention is paid to environmental outcomes from water developments in Pakistan. Consequently, water-dependent ecosystems of rivers, lakes, wetlands, and Indus Delta are in rapid decline. Excessive upstream surface water withdrawals and widespread pollution are the main causes of decline, but river fragmentation by infrastructure and changed sediment regimes also contribute.

2.2. WATER SECURITY UNDERMINING FACTORS

Water security in Pakistan is undermined by poor water resource management and poor water service delivery including irrigation and drainage services and domestic

water supply and sanitation services. In addition, some growing long-term water-related risks are not adequately recognized and poorly mitigated.

Pakistan water resource management is characterized by: poor water data, information and analysis; weak processes for water resources planning and allocation; environmentally unsustainable levels of water withdrawal; widespread pollution; and low water productivity in agriculture.

Water resources planning has historically focused on supply augmentation without addressing sustainable resource use or being linked adequately to broader economic planning. Although provincial water shares were formally defined under inter-provincial Water Apportionment Accord (WAA) of 1991, they seem economically suboptimal and there is insufficient clarity on risk sharing during times of acute scarcity. These deficiencies are expected to become starker with increasing water demands and climate change.

Conventional irrigation water allocation is suboptimal in terms of efficiency, equity, and transparency and contributes to low productivity and causes a lack of trust between farmers and service providers. Some improvements in agricultural water productivity in recent decades have been achieved through increased fertilizer use; mechanization including additional labor; and a huge increase in groundwater pumping even to extent of aquifer(s) mining. But there has been little improvement in water use efficiency and very little intensification or transition toward higher-value crops. Consequently, agricultural water productivity lags well behind most other developing countries of the World as shown in Fig. 2.

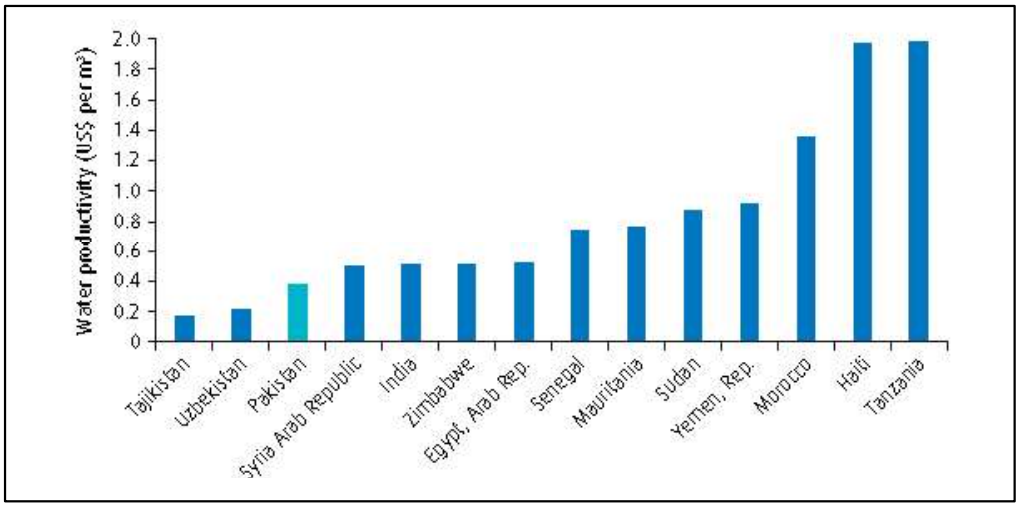


Figure 2: Agricultural Water Productivity in Selected Developing Countries

Irrigation service delivery is poor and contributes to low productivity. Hydraulic efficiency of water distribution network is very low, and water delivery across segments of command areas is inequitable. Irrigation services are not financially sustainable as service tariffs (water rates) are set too low and are decoupled from service quality. Poor operational performance in irrigation continues to exacerbate

waterlogging and salinization, especially in Sindh. With large-scale reclamation efforts during last 3-4 decades of 20th century, overall waterlogging has been significantly reduced. However, due to high surface water withdrawals and poor drainage, salt continues to accumulate in soils and groundwater in the lower Indus Basin, affecting agricultural productivity.

Domestic water supply coverage, though especially high for urban households, is declining because of rapid urbanization. However, quality of supply services is poor especially in terms of water quality and reliability. Sanitation services are variable. Open defecation is increasingly uncommon even in rural areas, but collection, treatment, and disposal of sewage effluent are all grossly inadequate. Most domestic water supplies from shallow ground water are, therefore, contaminated.

Climate change is the biggest long term and currently unmitigated external risk to Pakistan's water sector. Climate change is not expected to greatly alter average water availability over coming decades, but inflows will become more variable between and within years, increasing severity of floods and droughts. Climate warming is expected to drive water demands up by 5 to 15 percent by 2047 (after 100 years of independence) in addition to demand increases from population and economic growth. In Upper Indus Basin, accelerated glacial melting will increase the risks of dangerous glacial lake outburst floods (GLOFs). In Lower Indus Basin, sea level rise and increases in frequency and severity of coastal storms will exacerbate seawater intrusion into the Delta and coastal groundwater. In coastal Sindh, this will further degrade groundwater quality of dependent ecosystems and irrigation productivity.

A second overlooked risk is change in Basin-scale river sediment dynamics. Sediment dynamics in the Indus including sourcing, transport, and deposition have been significantly altered by increased water surface extraction. Without greater attention, these changes will increasingly threaten safety and operational performance of water infrastructure and health of river and Delta ecosystems.

2.3. HISTORIC WATER AVAILABILITY AND ITS UTILIZATION IN INDUS BASIN IRRIGATION SYSTEM

Weir controlled canal supplies in Indus Basin started in 1870. Since then, a major irrigation network has been established including the impact of Indus Basin Project executed to implement provision of IWT, 1960. This is represented in Annex-01 'Timeline of Major Irrigation And Water Resources Infrastructure in Pakistan, 1870 to Present'. Resultantly Pakistan's Indus Basin now possesses World's largest contiguous irrigation system as schematically shown in Fig. 3.

Some of Pakistan's water resources are well quantified, while others are poorly assessed or simply overlooked in most assessments. Surface water inflows to Pakistan from the Indus and its tributaries are measured sufficiently well to give high confidence to average annual flows. However, runoff generated within Pakistan including Balochistan outside the Indus Basin is not well measured and

is often ignored in resource assessments. Groundwater has usually been quantified in terms of withdrawals, but this leads to a significant double counting in resource estimates, because much of the groundwater is simply surface water withdrawals that seep from canals, distributaries and fields into the aquifers.

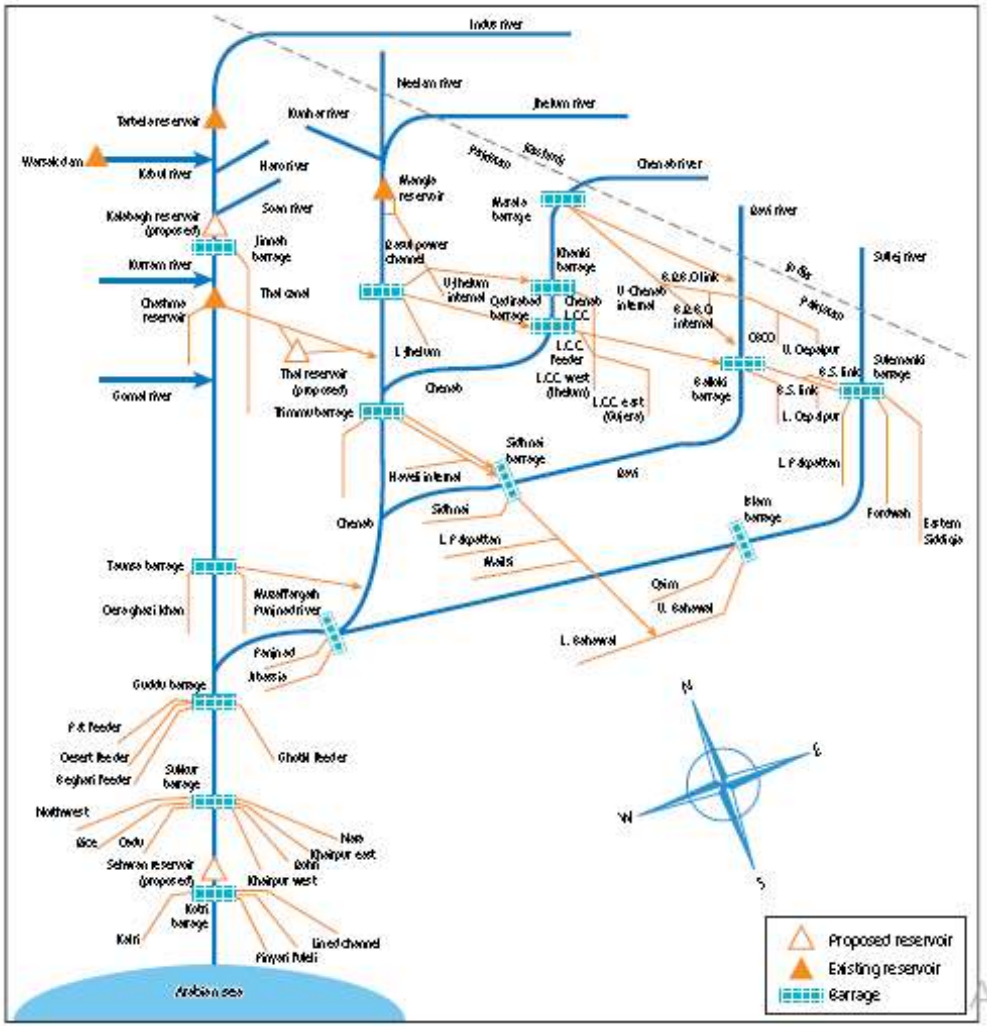


Figure 3: Indus Basin Irrigation System of Pakistan

A careful assessment of all water resources, drawing on a range of data and past studies, suggests that Pakistan's current total average annual renewable resource of Indus Basin is about 222 billion cubic meters (BCM) including: 170 BCM for Western Rivers (Indus including Kabul, Jhelum and Chenab); 3 BCM from Eastern Rives (Ravi, Beas and Sutlej; 32 BCM generation from within the Basin; 4 BCM river and flood recharge; and 13 BCM from rainfall recharge.

These renewable water resources are balanced by consumption side comprising: canal head withdrawals of 125 BCM; river system net losses of 68 BCM; and

outflow to sea of 30 BCM. Resultant 'Indus Basin Average Annual Water Balance' is shown in Annex-02, while the related numerical values are summarized in Table-1.

TABLE-1

INDUS BASIN
AVERAGE ANNUAL SURFACE WATER BALANCE [a)]

Inflows				Basin Consumption & Losses etc.			
Sr. No.	Item	Quantum		Sr. No.	Item	Quantum	
		MAF	BCM			MAF	BCM
1	River Inflows: -			1	Canal Head Withdrawals	101	125
	i. Western Rivers (Indus Including Kabul, Jhelum and Chenab)	138	170	2	Net River Losses	55	68
	ii. Eastern Rivers (Ravi, Sutlej & Beas)	2	3	3	Outflow to Sea	24	30
	iii. Sub Total ! (i+ii)	**140**	**173**	**4**	**Sub Total (1+2+3)**	**180**	**223**
2	Run-off Inside Pakistan (Estimated)	26	32				
3	River and Flood Recharge	3	4				
4	Rainfall Recharge	11	13				
5	**Total (1+2+3+4)**	**180**	**222**				

a): Based on post-Tarbela data
MAF: Million Acre Feet
BCM: Billion Cubic Meters

2.4. PER CAPITA WATER AVAILABILITY

Starting from about 6000 m^3 in 1960, per capita water availability has reduced to about 1100 m^3 between recent decades because of population growth as shown in Annex-03. This recent water availability approaching acute scarcity global indicator, considers all renewable water resources.

Progressive decade-wise reduction of per capita water availability is summarized in Table-2:

TABLE-2

PER CAPITA WATER AVAILABILITY IN PAKISTAN

Decade Ending	Approximate Per Capita [a)] Water Availability (m^3)
1960	6000
1970	4800
1980	3000
1990	2200
2000	1500
2010	1200
2020	1100

a) Considering all renewable water resources

Water demand is projected to rise, driven mostly by economic and population growth but also by climate warming. Therefore, demand management will be critical to stay within available water resource envelope as well efficiency improvements that can allow consumption to increase. Converging of supply and demand projections well be a key aspect of water security challenge for Pakistan.

Water withdrawal in Pakistan as a fraction of available resource is high compared to most other countries. However, adjusting for double counting of surface and groundwater withdrawals reveals that water stress may be extreme than commonly quoted. Severe groundwater depletion / mining is evident in Lahore, Quetta, and parts of southern Punjab. Therefore, greatest threat to long-term groundwater sustainability is balancing of recharge and pumping particularly in areas underlain by fresh water, considering contamination from nearby saline ground water intrusion and other pollutants.

Operational dynamics of surface and ground water across Indus Basin is summarized in Table-3.

TABLE-3

INDUS BASIN
AVERAGE ANNUAL INTERNAL OPERATIONAL DYNAMICS OF SURFACE AND GROUND WATER

Sr. No.	Item	Quantum	
		MAF	**BCM**
I.	**Surface Water Dynamics**		
1	**Surface and Rain Water Input**	**112**	**138**
2	Water Consumption:		
i	Crop Evaporation Losses	33	41
ii	Crop Consumptive Uses	65	80
iii	Ground-water Recharge	14	17
iv	**Sub-Total 2 (i+ii+iii)**	**112**	**138**
3	Net Balance (1-2)	0	0
II.	**Ground Water Dynamics**		
1	Recharge:		
i	Canal Leakage	22	27
ii	Rainfall Recharge	11	13
iii	Irrigation Recharge	14	17
iv	River and Flood Recharge	3	4
v	Sub-Total 1 (i+ii+iii+iv)	**50**	**61**
2	Ground Water Withdrawals	50	62
3	Net Balance (1-2)	0	1
III.	**Gross Crop-Water Consumption [(I2 (ii) + II (2)]**	**115**	**142**

2.5. INTERVENTIONS FOR IMPROVING WATER SECURITY

2.5.1. TACKLING WATER SECURITY

There is no single simple solution to tackle water security in Pakistan. It will take concerted effort on many fronts by all governments and water users over many years. Large infrastructure gaps must be filled, which require significant financial resources. Though provincial-level water sector financing has increased in recent years, federal financing has declined significantly in proportional terms. Collectively, sector financing is well below recommended levels. This is the case for: major infrastructure; reforms and institutional strengthening; urban services; flood mitigation; and environmental management.

Biggest challenges, however, are ones of governance, especially regarding irrigation and urban water. Governance challenges relate to inadequate legal frameworks for water at federal and provincial levels and incompleteness of policy frameworks and inadequacy of policy implementation. Policy deficiencies stem from institutional problems including unclear, incomplete or overlapping institutional mandates and a lack of capacity in water institutions at all levels. Behind these multiple challenges in formal governance arrangements are deeply embedded vested interests in status-quo that have proved resistant to reforms.

2.5.2. INFRASTRUCTURAL INTERVENTIONS

Most important infrastructure gaps are associated with water supply and sanitation services and irrigation and drainage services. Wastewater treatment infrastructure is woefully inadequate for both urban and rural communities. Treatment capacity is inadequate and existing infrastructure is poorly maintained and operated. Sewerage network coverage is very limited and the current partial network is poorly maintained. Water distribution networks are often similarly inadequate including aging. Many rural areas lack both public water and sanitation infrastructure. While irrigation infrastructure is very extensive following more than a century of incremental investment, the distribution network is getting outdated as well as poorly maintained. Despite considerable investment in drainage infrastructure, waterlogging continues in areas underlain by saline aquifers particularly in Sindh. Modernization of irrigation and drainage infrastructure is required on a massive scale, including upgrading flow control structures and installing real-time data acquisition systems for improved operations including monitoring.

Pakistan needs continued investment in flood protection infrastructure. Country has made moderate progress in flood mitigation, given the significant damage and disruptions from floods over the last 50 years of so. However, climate change will increase the risk of flood damage, requiring greater investment. Flood infrastructure should also be complemented with “soft” measures such as floodplain zoning, improved flood forecasting and early warnings.

2.5.3. CONSTRUCTION OF LARGE STORAGE RESERVOIRS

Currently, Pakistan is at the bottom of global list of reservoir storage value as ratio of mean annual inflow as shown in Fig.4.

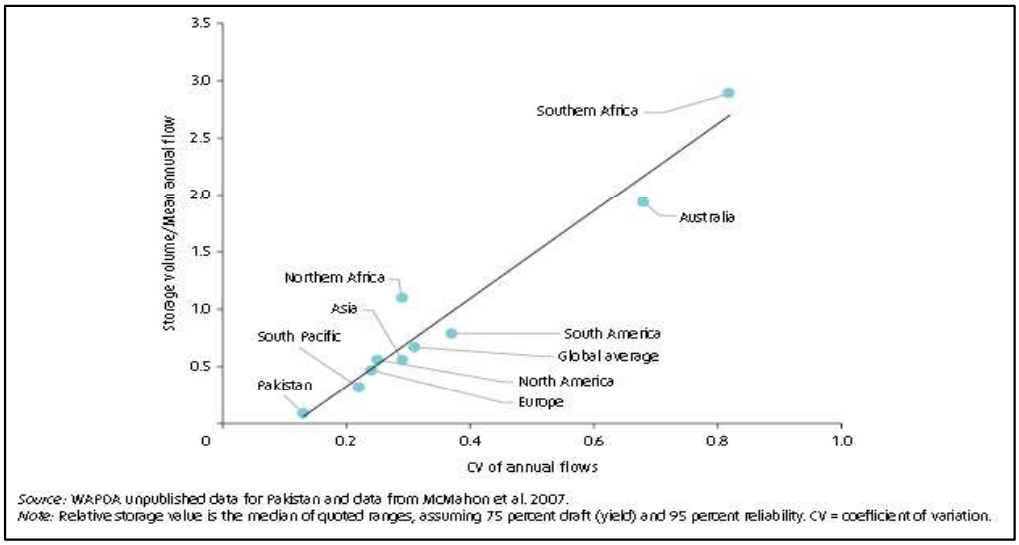


Figure 4: Reservoir Storage Volume as Ratio of Mean Annual Flow Compared to Coefficient of Variation of Annual Flow for Selected Countries and Regions

Large storage reservoirs can help improve some aspects of water security.

Priority Dam Projects for Construction in Pakistan' are listed in Table-4.

TABLE 4
PRIORITY DAM PROJECTS FOR CONSTRUCTION IN PAKISTAN

Dam	River	Generation Capacity (GW)	Live Storage		Estimated Cost (US$, Billions)	Status
			BCM	MAF		
Diamer Basha	Indus	4.50	7.9	6.4	11.18	Construction Started
Kurram Tangi	Kurram	0.08	1.1	0.9	0.70	Under Construction
Tarbela 4th Extension	Indus	1.35	-	-	0.83	Constructed & in Operation
Munda	Swat	0.74	0.9	0.7	1.40	Construction Started
Kohala	Jhelum	1.10	Run-of-River		2.40	Design / Procurement
Bunji	Indus	7.10	Run-of-River		6.84	Construction Ready
Dasu	Indus	4.32	0.8	0.6	5.21	Stage I (2.16 GW) Under Construction
Total		**19.19**	**10.7**	**8.6**	**28.56**	

While new reservoirs will provide direly needed irrigation water supplies, only financial benefits from hydropower either from storage or run-of-river facilities

justify viability of new dams due to free of charge provision of storage water to provinces for irrigated agriculture. New reservoirs will also mitigate floods and seasonal flow variations, both of which are expected to increase with climate change. Particularly, storage of Diamer Basha Dam upstream of Tarbela Dam with a live storage of 6.4 MAF (7.9 BCM) will slow its incremental loss of live storage caused by rapid sedimentation and increase its useful life by about 35 years.

Due to about 1/3rd (about 5 MAF or 6BCM) loss of on-line storage capacity caused by rapid sedimentation and lack of any major storage construction after Tarbela in 1977, it has not been possible to sustain even post-Tarbela base line average canal withdrawals of 105 MAF (130 BCM). On the other hand, WAA enhanced overall potential allocations over this base line by about 12 MAF (15 BCM). This was premised on the basis that additional large storage reservoirs will be constructed. Consequently, in post-WAA period of 1992-2005, various provinces suffered large annual shortfalls as compared to the enhanced water allocations aggregating to 117 MAF (144 BCM). This can be further appreciated from Annex-04.

2.5.4. LEGAL FRAMEWORKS IMPROVEMENTS

Existing legal frameworks for water management need to be far more comprehensive. Out of 14 legal legislations identified as important for sound water resources management, which is a provincial subject, only 6 are among provincial frameworks including 4 concurrent with national as listed in Table 5.

TABLE-5

PAKISTAN WATER MANAGEMENT RELATED LEGAL FRAMEWORKS

Sr. No.	Legislation	Enacted	Last Amended	Subject
1	Penal Code, Act XLV	1860	2016	N
2	Easements Act	1882	1960	N
3	Water and Power Development Authority (WAPDA) Act	1958	1998	N
4	Constitution of Islamic Republic of Pakistan	1973	2015	N
5	Water Apportionment Accord (WAA)	1991	1991	P
6	Indus River System Authority (IRSA) Act	1992	1992	P
7	Environmental Protection Act (EPA)	1997	1997	N
8	Indus River System Authority (Amendment) Ordinance	1998	1998	N+P
9	WAPDA (Amendment) Ordinance	1998	1998	N
10	IRSA (Amendment) Ordinance	2000	2000	N+P
11	IRSA Regulations	2000	2000	N+P
12	Council of Research in Water Research Act	2007	2007	N
13	IRSA Regulation for Issuance of NoC and Water Utilization Cess for Hydel Power Projects Requiring Use of Water	2010	2010	N+P
14	National Water Policy	2018	2018	N

Notes: *N = National*
P = Provincial
N+P = National and Provincial

Pakistan National Water Policy (2018) envisages strong support for improving water resource management, echoing other policy documents such as National Climate Change Policy. However, significant policy work is required at the provincial level, because policy frameworks for irrigation and water resources management are partial, fragmented or nonexistent and implementation has been inadequate.

Provincial policy frameworks for urban water services should be clarified and aligned with relevant legislation, including that of local government. Institutional responsibilities for several aspects of water resource management need to be better delineated both at national and provincial levels and between entities at these levels. The institutional responsibilities for urban water need to be clarified and overlaps resolved.

3. WATER SECURITY CONSTRAINTS TO DEVELOPMENT

Because of sustained and rapid population growth, relative water availability has shrunk to less than a quarter of what of it was half a century ago (refer Table 2). Municipal and industrial water demands are increasing and environmental water allocations need attention and should be agreed and implemented.

State-of-art economic modeling by the World Bank suggests, however, that despite projected population increase and climate change, water scarcity will not prevent Pakistan from reaching upper middle-income status by 2047 i.e. 100 years after its creation. GDP Growth by 2047 under various modelling scenarios of the World Bank is summarized in Table-6.

TABLE – 6
WORLD BANK'S MODELED ECONOMIC DEVELOPMENT SCENARIOS IN PAKISTAN AND PROJECTED PER CAPITA ANNUAL INCOME BY 2047

Sr. No.	Scenario	Overall Annual		Climate Warming in Mean Annual Temperature By 2047
		GDP Growth (%)	Per Capita Income (US$)	
1.	Business As Usual	1.9	2200	Current Rate of 1°C & Faster Rate of 3°C
2.	Accelerated Economic Growth	4.9	6000	Current Rate of 1°C & Faster Rate of 3°C

Although population growth is slowing, projections suggest Pakistan's population will exceed 300 million by 2047, driving water demands much higher. Without serious demand management and reform, and if the climate warms rapidly, water demand could increase by nearly 60 percent by 2047 (refer Annex-05). This would exceed water availability, even if no environmental limits were placed on withdrawals. Largest increases in demand will be for irrigation. Population and economic growth are the main drivers, but climate warming will contribute

significantly. The fastest rates of demand growth will be for domestic and industrial supply. These changes will require a major focus on demand management to improve water use efficiency and water productivity.

For many years, adequate water availability and modest urban demands have resulted in little urgency and few incentives to improve water use efficiency or to seriously tackle demand management. Food production increased to keep pace with population growth, although food security was compromised by problems of affordability, access during occasional shortages and dietary diversity. Water planning and investment was dominated by large supply-side projects that did not improve water productivity.

Water resource constraints mean that a far stronger focus on demand management is required. Water losses must be reduced and water productivity growth accelerated. It is commonly believed that Pakistan has inadequate water storage and that new reservoirs will dramatically enhance water supply. In addition, reservoirs will buffer inflow variations due to climate change and stabilize supply. As already mentioned, existing reservoirs have lost about 1/3rd of their live storage capacity, which cause Rabi and early Kharif irrigation water shortages even to sustain 105 MAF (130 BCM) bench mark of WAA (Water Apportionment Accord 1991). On the other hand, given the severe environmental degradation of the lower Indus River and Delta, partly caused by high upstream water abstractions, any increase in withdrawals, especially in drier years, shall have to be carefully assessed in terms of additional environmental degradation.

Rationalization of existing water allocations for irrigation as per WAA will be critical to driving economic growth. Demand growth and changing demand patterns will require switching over to low delta crops as well as focus upon higher-value crops.

Pakistan's focus on high delta crops is resulting in extremely low agricultural productivity when compared to other low / medium income countries of the World (refer Annex-06).

Water demands outside of agriculture, within the coming decades, will require limiting growth in agricultural consumption of water. Until then, water consumption in agriculture could increase without increasing water withdrawals. Firstly, this will require reforms and investments that dramatically reduce water losses. Secondly, in the irrigation system water will need to be secured and managed to protect water-related environmental services and benefits. With additional storage this may be possible without reducing withdrawals but requires confirmation through more detailed modeling. Thirdly, use of water for irrigation needs to be dramatically improved. To ensure continued food security and to contribute to accelerated economic growth, the productivity of water in agriculture must be greatly increased. Reforming distorting agricultural policies that support high delta crops like rice and sugarcane will help move water toward higher-value crops.

4. PROSPECTS OF FURTHER DEVELOPMENT

Changes in diet, already apparent as incomes rise, will further change patterns of food demand. If production of low-value cereals declines in response to falling

demand, more water may shift to growing cotton for export. Cotton and the associated textile industry generate considerable export income for Pakistan and should remain economically attractive over the long term, especially if greater value-addition post-harvest is achieved. These benefits can only accrue, however, if major reductions in irrigation water losses or crop consumption can be achieved.

Assuming optimistic rates of economic growth, World Bank's modeling suggest that Pakistan can reach upper-middle-income status (GDP of US$6,000 per capita) by 2047 (refer Table-6). This will ensure adequate food supply, improve environmental sustainability and deliver better municipal and industrial water security even in the context of a rapidly warming climate. However, this will not be easy, and will require concerted efforts on many fronts.

5. IMPLICATIONS OF BUSINESS AS USUAL

Conversely, without major reforms and business as usual (BAU), Pakistan will see only minor improvements in water productivity and continued slow economic growth to reach only US$2,200 GDP per capita by 2047 (refer also to Table 6). Urban water security will likely decline with worsening environmental degradation. A lack of resilience, especially to increasing drought severity, could lead to increased conflict over water between provinces and various sectors.

6. INTERVENTIONS FOR IMPROVED WATER SECURITY

In this regard, 12 high-level recommendations have been made by the World Bank in its 2018 Report 'Pakistan – Getting More from Water', as listed in Annex-07. These comprise: six (6) for improved water resource management; three (3) for improved service delivery; and three (3) for improved risk mitigation. These address major areas of poor sector performance and will ensure that water security does not constrain Pakistan's economic development ambitions.

Accordingly, interventions for improved water security can be grouped as: -

i. Water Resource Management
ii. Water Service Delivery
iii. Water Related Risk Management

6.1. WATER RESOURCE MANAGEMENT

This should cover: -

i. Strengthening water data, information, mapping, modeling and forecasting.
ii. Establishing a multistakeholder process of basin-scale water resource planning.
iii. Establishing provincial water planning and intersectoral water allocation mechanisms.
iv. Accelerating agricultural water productivity increases.
v. Adopting conjunctive planning and management of surface and ground-water.
vi. Constructing new storages and optimize operations including existing reservoirs.

6.2. WATER SERVICE DELIVERY

This should cover:-

i. Modernizing irrigation and drainage infrastructure for improved operations.
ii. Reforming urban water governance and close infrastructural gap.
iii. Improving rural sanitation.

6.3. WATER-RELATED RISK MITIGATION

This should cover: -

i. Improving understanding and management of climate risks specially to Lower Indus and Delta.

ii. Strengthening planning and management of water–energy interactions.

iii. Improving understanding and management of basin-scale sediment dynamics.

7. PROPOSED WAY FORWARD

Above recommendations in terms of complexity, urgency and scale of water security impact (bubble size) are reflected in Annex-07. For each recommendation, more actions will be required for reforming water governance (laws, policies, and institutions) and infrastructure investments.

Pakistan's National Water Policy (2018) outlines many of required reforms and investments to improve water security. It can provide a platform for increased sector dialogue, especially between the provinces, but also among diverse stakeholders within the provinces. Establishing an implementation plan for the National Water Policy that identifies agreed priority actions with clear responsibilities is critical. Implementation will require realistic assessment and commitment to increased sector financing and a robust and transparent process for tracking and reporting implementation progress to demonstrate political commitment and to ensure accountability. Given the long history of significant inter-provincial tensions around water sharing, establishment of a National Water Council as proposed in National Water Policy is fundamental. National Water Council should establish long-term social, environmental, and economic objectives for the management of the Indus Basin water resources in the national interest. These will also guide cooperative Basin planning, provincial water management and help in economic growth to have a place for Pakistan among Upper Middle Income Status countries of the World by 2047 after 100 years of its creation.

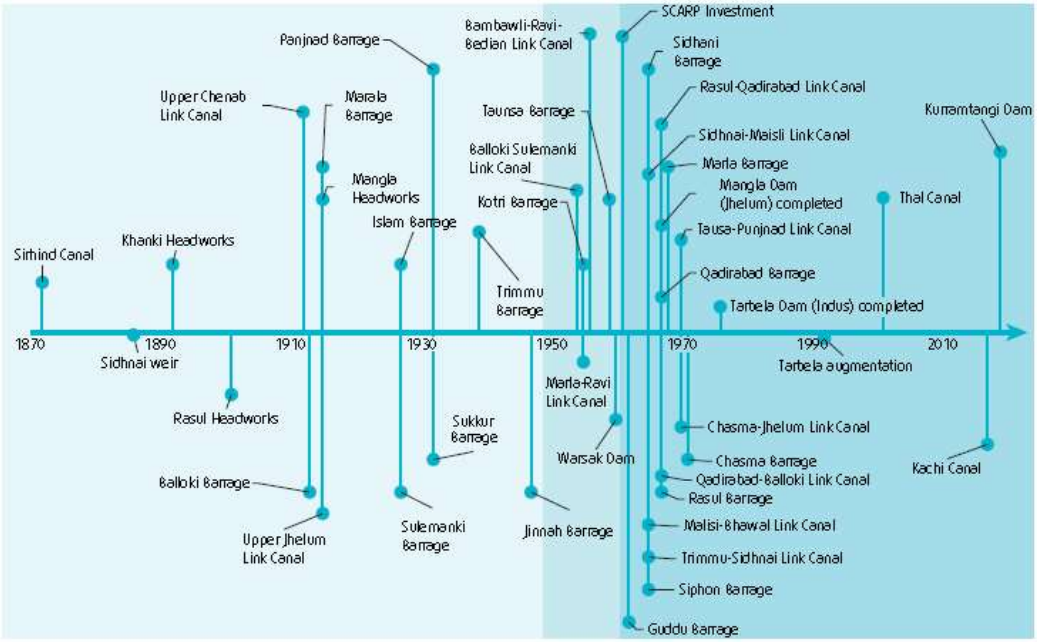
8. REFERENCES

I. World Bank Report titled 'Pakistan Getting More From Water', 2019

II. Other Relevant Literature (As listed in Annex-08)

ANNEX – 01

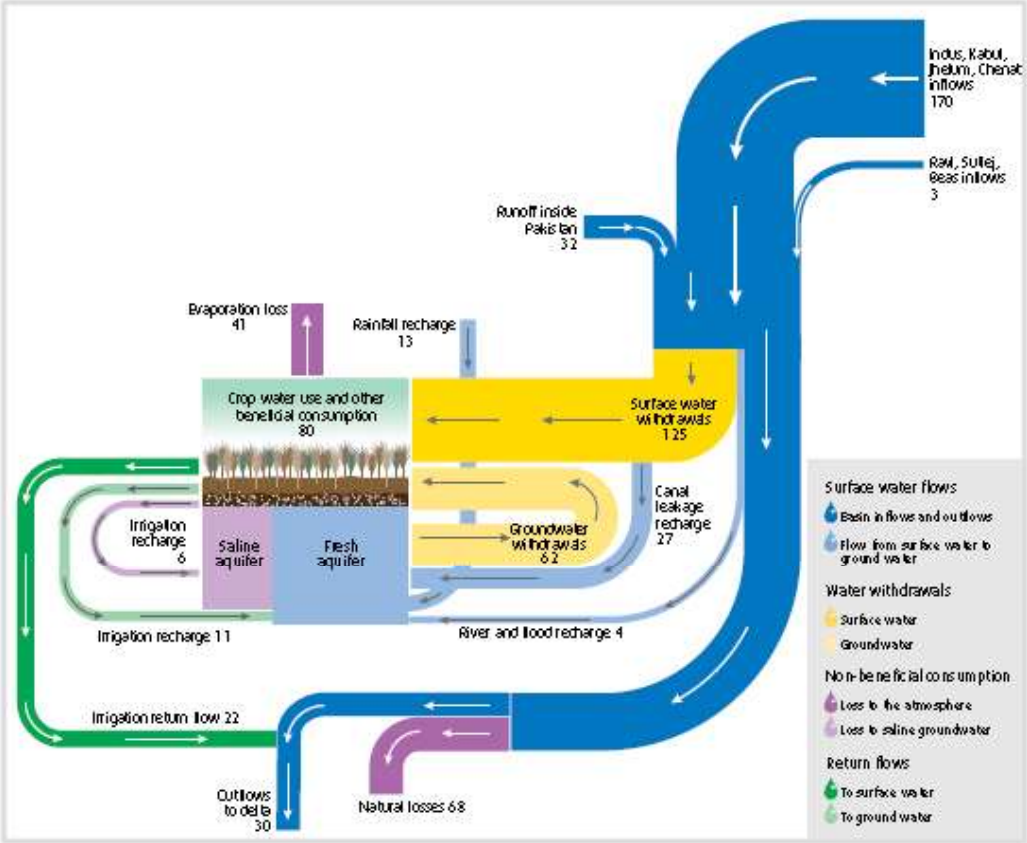
TIMELINE OF MAJOR IRRIGATION AND WATER RESOURCES INFRASTRUCTURE IN PAKISTAN, 1870 TO PRESENT



Note: Shadings indicate pre-Pakistan, pre-IWT and post-IWT periods.

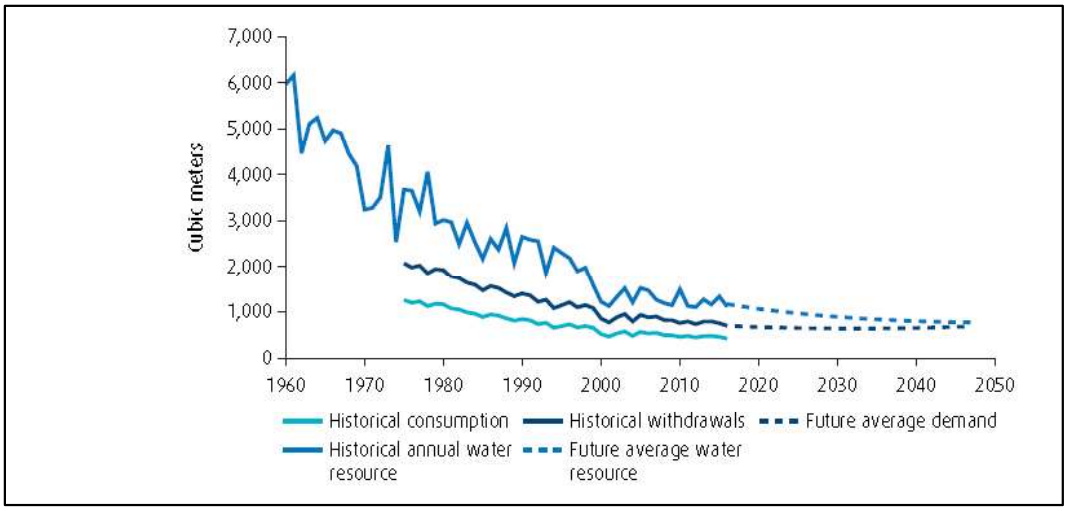
ANNEX – 02

INDUS BASIN AVERAGE ANNUAL WATER BALANCE



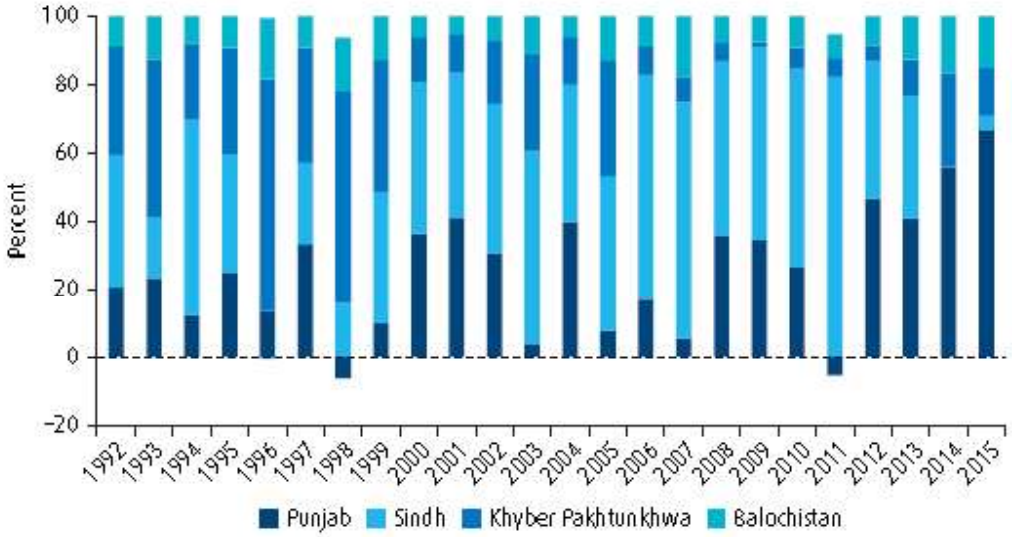
ANNEX – 03

HISTORICAL WATER AVAILABILITY, WITHDRAWALS AND CONSUMPTION PER CAPITA; AND PROJECTED PER CAPITA AVAILABILITY AND DEMAND



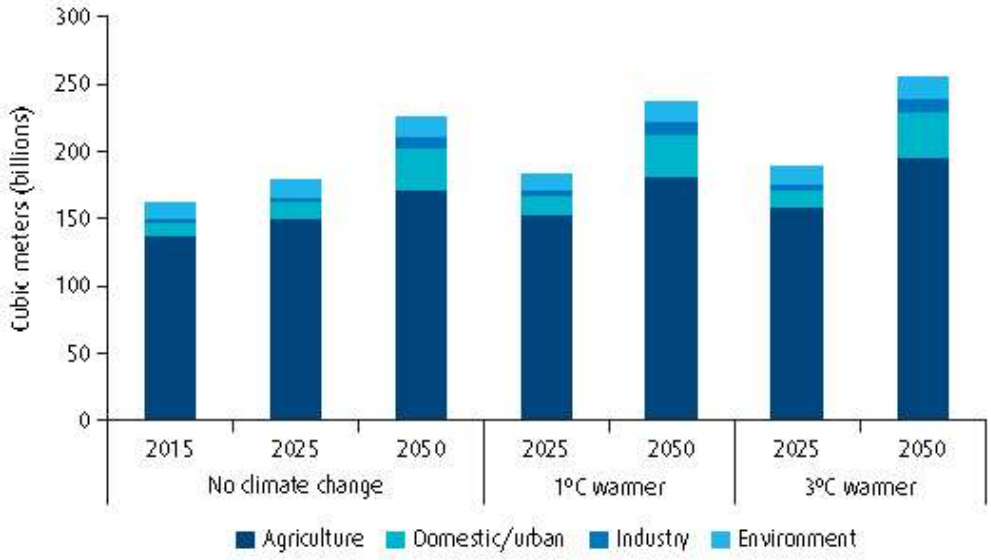
ANNEX – 04

SHARE AMONG PROVINCES OF ANNUAL SHORTFALL OF CANAL WITHDRAWALS RELATIVE TO WATER APPORTIONMENT ACCORD BASELINE ALLOCATION VOLUME IN PAKISTAN, 1992–2015



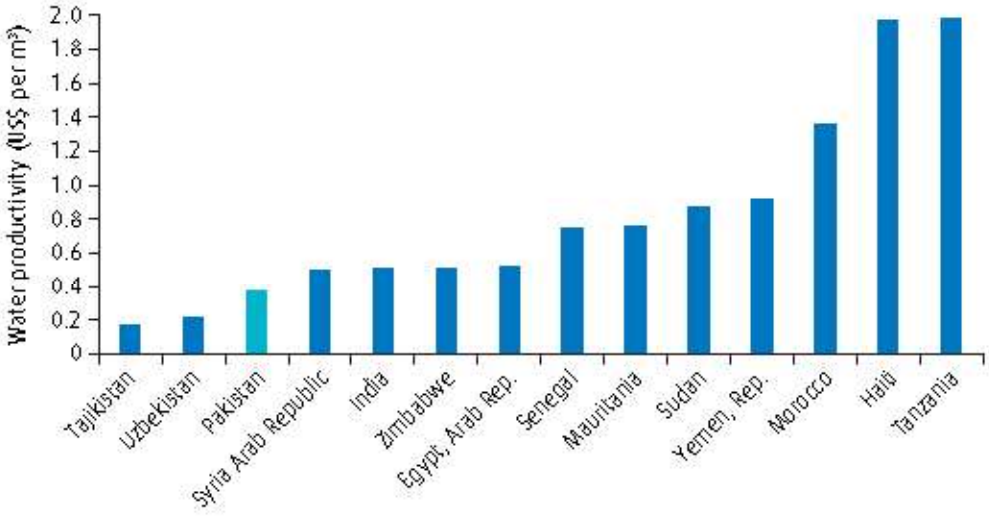
ANNEX – 05

PAKISTAN TOTAL WATER DEMAND IN 2015 AND PROJECTED FOR 2025 AND 2050



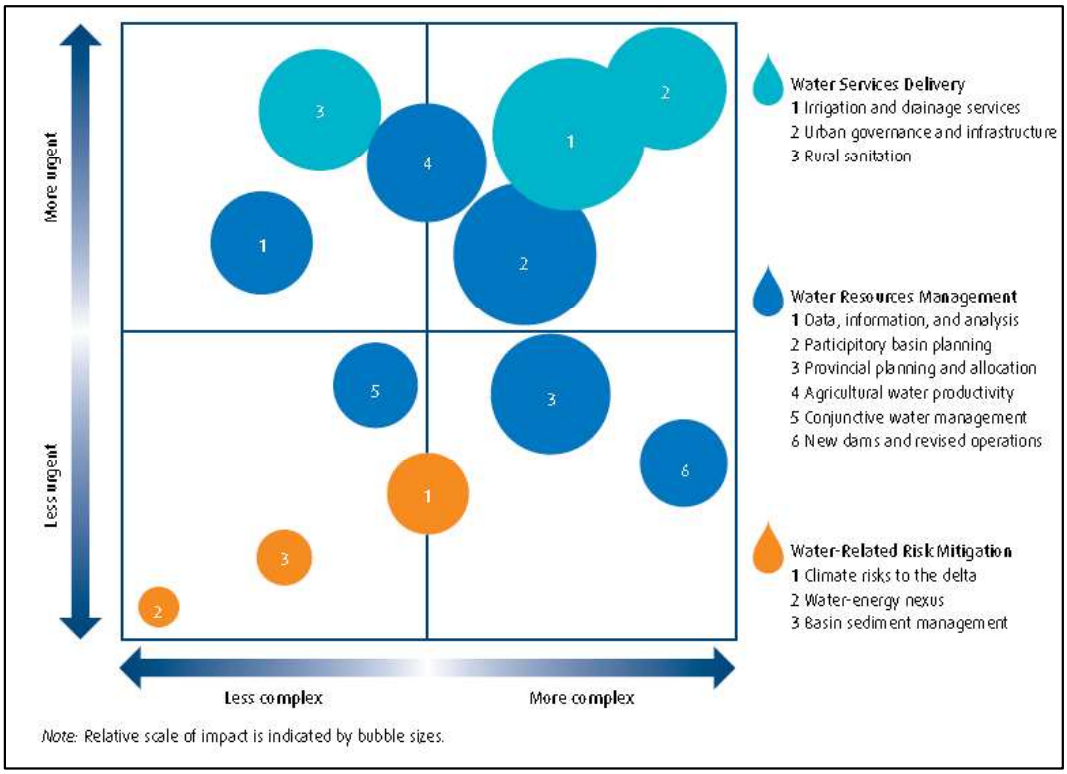
ANNEX – 06

AGRICULTURAL WATER PRODUCTIVITY IN SELECTED COUNTRIES



ANNEX – 07

COMPLEXITY, URGENCY, AND SCALE OF IMPACT OF KEY RECOMMENDATIONS



Note: Relative scale of impact is indicated by bubble sizes.

ANNEX – 07

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