Water Crisis

"Thousands have lived without love, not one without water". (W.H Auden)

"Anyone who can solve the problems of water will be worthy of two noble prizes - one for peace and one for science" John F Kennedy

1. Current Water Situation:

- Today, Pakistan is below the threshold of a water stressed country and is water scarce with ***per capita water availability at only 930 cubic metre per annum***.(Freshwater | WWF - WWF-Pak)

- the ***country is heading towards a 'massive water shortage'***, somewhere ***between 27 per cent and 35 per cent,*** only months after unprecedented floods submerged large swathes of lands across Sindh and southern Punjab, **Irsa (Indus River system Authority)** sources told Dawn.
- In view of the higher shortage, the Indus River System Authority (Irsa) would be compelled to follow ***a controversial three-tier water management mechanism*** for distribution of shares to provinces
- excessive levels of ***toxic metals linked to coal-mining activity*** had been found in drinking water, resulting in the 'poisoning' of water sources. They claimed that due to high levels of arsenic, mercury, lead and other toxic substances, local people were suffering from health problems,
- Pakistan is currently facing a water crisis. According to the Pakistan Institute of Development Economics (PIDE), Pakistan ranks 14 out of 17 "extremely high water risk" countries in the world, as *the country wastes one-third of water available.* ***More than 80 percent of the country's population faces "severe water scarcity."***1 The annual per capita water-availability in Pakistan is about 1,100 cubic meter (m3); below 1,000 m3, countries begin experiencing chronic water stress.
- According to *International Monetary Fund (IMF), Pakistan will be fully dried and barren by 2025* if the necessary measures are not taken to preserve the water.

- Almost 30 million Pakistanis have no access to clean water, *80 percent of people living in 24 major cities do not have access to clean water* and 16 million slum dwellers of Karachi do not have access to running water. (Growing Water Scarcity issue in Pakistan by Mir Sher Baz Khetran)
- Global Risks Report of the World Economic Forum ranked water crises as the t*hird most important global risk in terms of impact on humanity* Global Risks Report of the World Economic Forum ranked water crises as the third most important global risk in terms of impact on humanity.
- Pakistan has the highest water intensity rate in the world. This is the amount of water in cubic metres used per unit of GDP . In the *National Water Policy 2018, the federal government and provincial institutions recognized that with rising temperatures, the consumption of water in all sectors – domestic, industrial, and agriculture* – is set to increase.
- . By far the highest consumer of water is agriculture which uses approximately 94-95 percent of all freshwater resources. The remaining 5 percent is divided between the industrial and domestic sectors.
- *Currently, Pakistan has a water storage capacity of 30 days*, while the US has 900 days, Egypt 700 days, and India 170 days. The least water storage capacity of any country should be 120 days and Pakistan is not meeting or even close to this criteria.
- Pakistan is considered to have crossed the "water scarcity line" in 2005, according to Pakistan Council of Research in Water Resources (PCRWR).
- According to Muhammad Khalid Rana, from the Indus River System Authority (IRSA), Pakistan is extremely short on reservoirs and can only save water for 30 days. Furthermore, he states that Pakistan receives almost 145 million acre feet of water but can only save 13.7 million acre feet of water. He goes on to say Pakistan needs 40 million acre feet of water but 29 acre feet is wasted due to lack of dams.
- The United Nations Development Programme (UNDP) and Pakistan Council of Research in Water Resources (PCRWR) warn of absolute water scarcity and a drought by 2025 if such problems prevail.

2. Importance of water in Pakistan

A. Water Security
B. Agriculture, one fitfth of national GDP, half of it is from irrigated crop, irrigation 22 Billion USD
C. Hydropower= 1 to 1.5 Billion USD
D. Poor social outcome
E. Human Right- basic right to access clean water

Water Security
- Water security describes the social, economic, and environmental outcomes—beneficial and detrimental— from how water is managed and used. Assessing these outcomes indicates that Pakistan is not water secure. Pakistan is well endowed with water—only 16 countries have more water—but because Pakistan is the world's sixth most populous country, water availability per person is comparatively low.
- Economy and water security relation: y. There are 32 countries with less water per person than Pakistan; across these countries the 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—all African nations with little irrigation investment and a heavy reliance on traditional rainfed agriculture.

Year	Population (million)	Water Availability (m^3)
1951	34	5300
1961	46	3950
1971	65	2700
1981	84	2100
1991	115	1600
2001	148	1200
2011	170	1050
2025	267	660

Source: UNDP Report (2005)

Factor Leading to water crisis

A. **Water Resources Management:** Water resources management in Pakistan does little to protect water-dependent ecosystems either by way of environmental flows or pollution control. (WB)

(i) poor water data, information, and analysis;

(ii) weak processes for water resources planning and allocation; No formal mechanisms exist within provinces for reallocating water between sectors to match shifting demands or to cope with extreme drought

(iii) environmentally unsustainable levels of water withdrawal;

(iv) widespread pollution;

(v) low water productivity in agriculture. Irrigation water allocation is suboptimal in terms of efficiency, equity, and transparency, contributing to the low productivity of irrigated agriculture and causing a lack of trust between farmers and service providers. recent decades have been achieved through increased fertilizer use, additional labor, and a huge increase in groundwater pumping. But there has been little improvement in water use efficiency and very little intensification or transition toward higher-value crops. Agricultural water productivity lags well behind that of most other countries

B. Poor Water Service Delivery

- Irrigation service delivery is poor and contributes to low productivity.
- Hydraulic efficiency of water distribution is very low, and water delivery across command areas is inequitable.
- Irrigation services are not financially sustainable and financial performance is declining.
- Service tariffs are set too low and are decoupled from service quality, and the operational costs of service providers are far too high.

- Poor operational performance in irrigation continues to exacerbate waterlogging and salinization, especially in Sindh.
- Despite large-scale reclamation efforts, high water withdrawals and poor drainage mean salt continues to accumulate in soils and groundwater in the lower Indus Basin, affecting agricultural productivity.
- Domestic water supply coverage is high—especially for urban households, but coverage is declining because of rapid urbanization. And although coverage is high, the 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 water supplies are therefore contaminated.

C. Limited Water Supply

D. Storage capacity of Dams

E. <u>Climate Change</u>

- 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 the severity of floods and droughts. Climate warming is expected to drive water demands up by 5 percent to 15 percent by 2047, in addition to the demand increases from population and economic growth. In the upper Indus Basin, accelerated glacial melting will increase the risks of dangerous glacial lake outburst floods. In the lower Indus Basin, sea level rise and increases in the frequency and severity of coastal storms will exacerbate seawater intrusion into the delta and into coastal groundwater. In coastal Sindh, this will further degrade groundwater quality, groundwaterdependent ecosystems, and irrigation productivity.
- A second overlooked risk is change in basin-scale river sediment dynamics. Sediment dynamics in the Indus—sourcing, transport, and deposition— have been significantly altered by water resources development. Without greater attention, these changes will increasingly threaten the safety and operational performance of water infrastructure—and the health of river and delta ecosystems.

F. Population Growth/ Unplanned Urbanization

G. Drying Rivers

H. <u>Poor Water Management</u>

- Water resource management is compromised by (i) poor water data, information, and analysis; (ii) weak processes for water resources planning and allocation; (iii) environmentally unsustainable levels of water withdrawal; (iv) widespread pollution; and (v) low water productivity in agriculture

I. Water Pollution

J. Ground Water Depletion

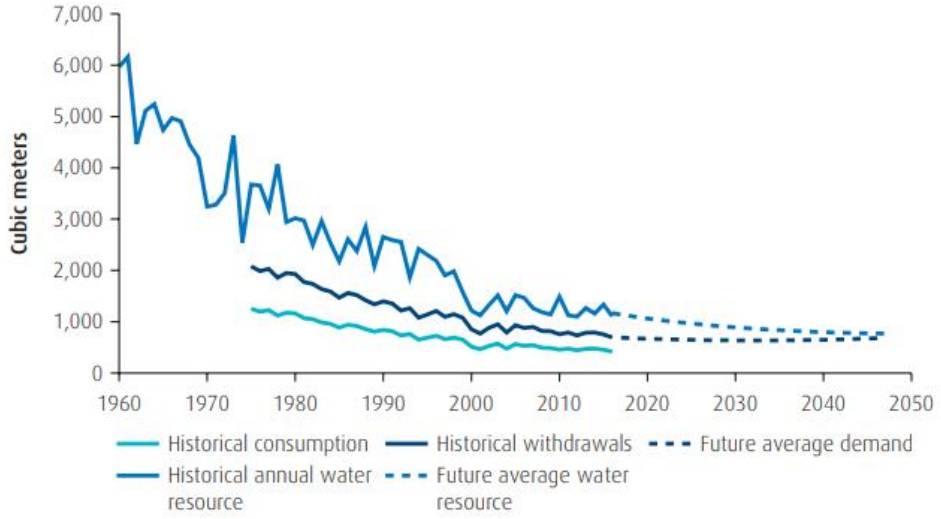
K. Water Policies

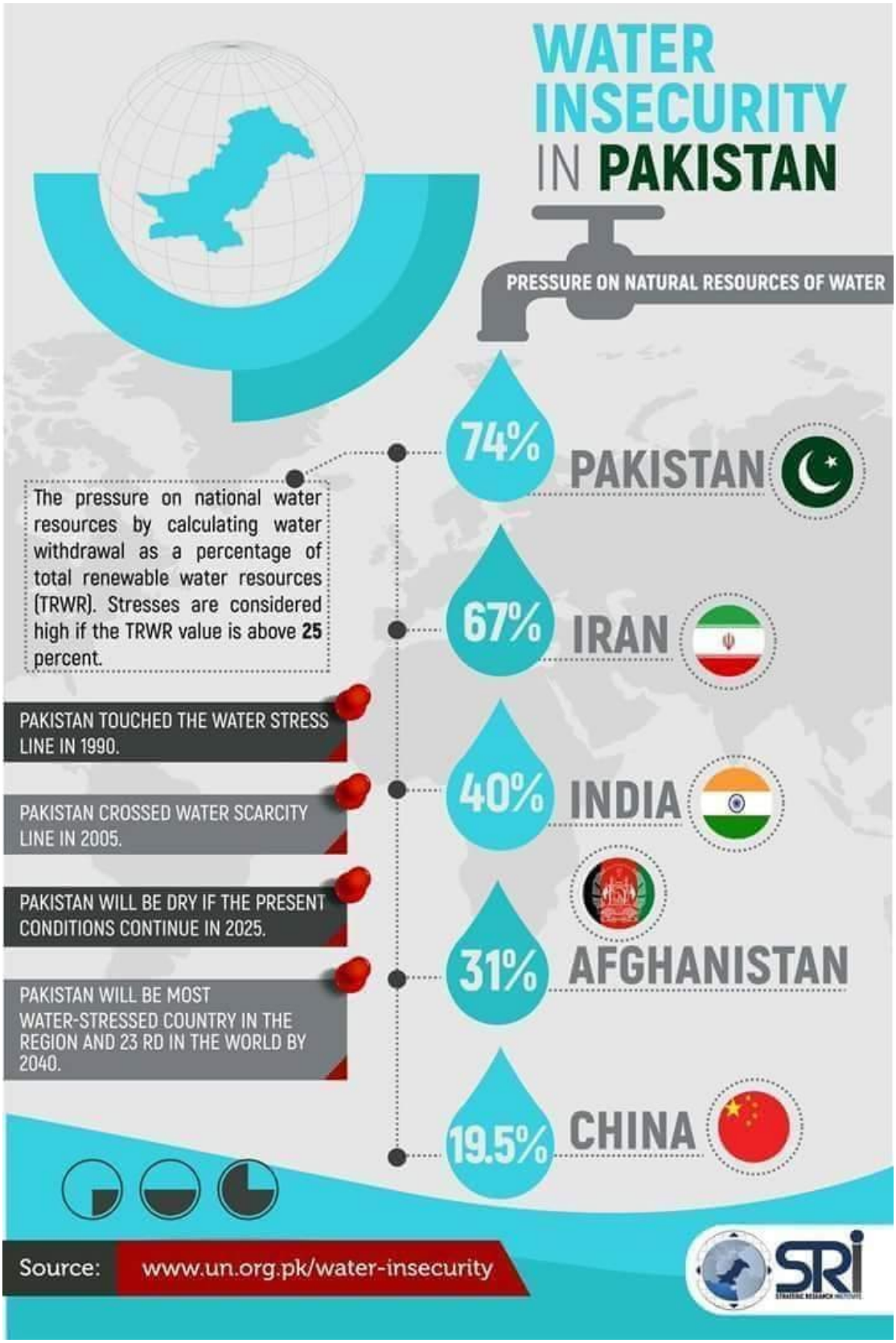
L. Poor water servise delivery (irrigation and drainage service)

<u>How well are Water Resources Understood?</u>
<u>From World Bank Perspective</u>

- Some of Pakistan's water resources are well qualified, while others are poorly assessed or simply overlooked in most resource assessments.
- The 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 in 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: much of the groundwater is simply surface

water withdrawals that seep from canals, distributaries, and fields into the aquifers. 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 is 229 billion cubic meters (BCM).
- Water availability per capita varies between years because of climate fluctuations, but in recent decades has declined because of population growth.
- Withdrawals per capita have declined with rising population, while actual consumption has remained a fairly constant proportion of withdrawals, given little improvement in water use efficiency.
- Demand management will be critical to stay within the available resource envelope, as will efficiency improvements that can allow consumption to increase. The converging supply and demand projections highlight a key aspect of the water security challenge for Pakistan.
- owever, adjusting for the double counting of surface and groundwater withdrawals reveals that water stress is less extreme than commonly quoted, although the stress on water ecosystems is still high. Severe groundwater depletion is evident in Lahore, Quetta, and parts of southern Punjab. But depletion is a very small fraction of the overall groundwater balance, and in any case, it follows decades of water-level rise caused by excessive irrigation.





How Good Water Management can help economy of Pakistan?

-

Impacts of Water Crisis in Pakistan

A. <u>Water Borne Disease:</u>

- Water-borne diseases (cholera, typhoid, hepatitis, and diarrhea) are a leading cause of suffering and death in Pakistan and reflect widespread contamination of water supplies by sewage effluent. The total health burden from water-related diseases is difficult to assess because of a lack of hospital records and limited reporting; however, the burden is disproportionally borne by poorer children and other vulnerable groups. An estimated 20 percent to 40 percent of hospital admissions and a large proportion of infant deaths have been linked to water-related diseases (Azizullah et al. 2011)
- Poor water supply, sanitation, and hygiene contribute to childhood stunting. The main determinants of stunting are food insecurity, inadequate personal care and feeding, an unhealthy environment, and inadequate health care. Poor water services influence all of these factors. Despite significant reduction in poverty across Pakistan, stunting rates remain high at 44 percent nationally and over 50 percent in Balochistan and Federally Administered Tribal Areas (FATA).
- Water-related diseases are a leading cause of suffering and death in Pakistan, and poor water supply, sanitation, and hygiene contribute to very high levels of childhood stunting. Domestic water supplies are generally unsafe, with contamination by sewage effluent, industrial effluent, and geogenic arsenic common, but poorly assessed, especially in rural areas.

B. Poor Sanitation

C. Food insecurity

D. <u>Energy Shortage</u>: 30 electricity is Hydroeletric. Untapped potential of hydroelectricity

E. Induced migration:

F. Environmental outcomes:

- Pakistan's environment resources and ecosystems are under increasing stress from high levels of water withdrawal, widespread water pollution, rapid urbanization, and agricultural expansion. Biodiversity loss, declining fish stocks, and degradation of internationally important ecosystems in the Indus Delta and other parts of the Indus Basin are key consequences.
- The Indus Delta—the fifth largest delta in the world—is characterized by rich biodiversity and valuable ecosystem services, including productive fisheries and coastal storm protection by mangrove forests. The area is estimated to be around 0.6 million hectares (Amjad, Kasawani, and Kamaruzaman 2007), with mangrove forests originally covering more than one-third of the total area. However, reduced river flows and sediment loads—and sea level rise—are driving a multifaceted environmental crisis for the delta, including sea water intrusion, soil salinization, mangrove forest loss, reduced freshwater supply, and depleted fisheries. The 17 channels that once delivered freshwater to the delta have been reduced to one (Kidwai et al. 2016), and no freshwater reaches the delta for 138 days per year on average.
- Sediment delivery to the delta is just 4 percent of predevelopment level. Construction of dams and barrages has reduced sediment delivery to the delta from an estimated 270 million tonnes per year to around 13 million tonnes per year (Syvitski et al. 2013). Flow reductions have led salinity in the delta to increase significantly, leading to a reduction in plant diversity:

G. <u>Floods and Droughts:</u>

- Flooding causes direct financial loss because of infrastructure damage and temporary reductions in agricultural and business productivity. The 2022 flood caused losses estimated at US$30 billion, and affected 40 million people
- Floods are the most frequent and damaging natural hazard in Pakistan. Over the past 65 years Pakistan has experienced more than 30 major floods affecting significant fractions of the population (figure 2.7). The 2010 floods affected 20 million people

H. <u>Women inequality:</u>

- Excluding women from water information perpetuates gender inequality in Pakistan. Early warning systems use a language and medium not accessible to women and other excluded groups, thus increasing their vulnerability to water-related disasters (Mustafa et al. 2015). Water–gender relationships influence social outcomes, including the limited presentation of

women in formal water management institutions. Global evidence indicates gender differences in the perceptions of, and coping strategies, for drought. Women are more proactive in adapting water management strategies to drought even when excluded from formal water management arrangements (Su et al. 2017).

I. Internal and external conflicts

J. <u>Economic Benefits:</u>

- Economic Benefits: The direct benefits to the economy from irrigation are the order of US$22 billion per year.
- The major economic benefits are from irrigation and hydropower.
- Irrigation, predominantly in Punjab, contributes around US$22 billion to the economy annually. The four major crops (wheat, rice, sugarcane, and cotton) contribute US$14 billion (less than 5 percent of GDP) but are responsible for 80 percent of all water use. The full agricultural sector (including cropping, livestock, forestry, and fisheries) employs 43 percent of the labor force.
- Water productivity can also be considered in the economic value generated per unit volume of water withdrawn. The economic return per unit of total water withdrawn (surface and groundwater) is significantly higher in Punjab than in Sindh (table 2.3), even though yields per hectare are generally much lower.
- Losses: Conservative estimates suggest average annual losses of about 4 percent of GDP (Sadoff et al. 2015), considering inadequate water supply and sanitation, flood damage to property, and water scarcity in agriculture.
- Other water-related economic impacts, such as loss of ecosystem services and the indirect costs of waterrelated disasters, are additional, suggesting the total economic costs of water insecurity are much higher.
- Flooding causes direct financial loss because of infrastructure damage and temporary reductions in agricultural and business productivity. The 2022 flood caused losses estimated at US$30 billion, or 6 percent of the year’s GDP

Controversies between Provinces:

- Study from *" Inter-provincial water conflicts in Pakistan by Harris Mushtaq" , " Water Management in Pakistan: Roots of interprovincial Conflicts by Tariq Anawar Khan"*
- Punjab believes that system losses or conveyance losses were around 7pc and 8pc, given the huge water quantities absorbed by the farmlands in super floods in Rabi season that has just ended, whereas Sindh insists system losses ranged between 35pc and 40pc, particularly in its territories between Chashma and Kotri barrages.

Historical Roots of Inter-Provincial Conflicts in Pakistan

a) The Tripartite Agreement (1921)
b) The Indus Discharge Committee (IDC) (1921)
c) Anderson Commission (1937)
d) Rao Commission (1945)
e) Indus Water Treaty (1960)
f) AkhtarHussain Commission (1968)
g) Chief Justices Commission (1977)
h) Water Apportionment Accord (1991)

- One such conflict exists between Punjab and Sindh and they share the history over the Indus River dating back over a century when for the first time in 1901 conflict between the two provinces came to the fore. Punjab was prohibited that without the consent of Sindh, they are not allowed to take a single drop of water and these orders were passed by the then Indian irrigation commission.
- The next fire between the two provinces was ignited in 1919 when Punjab was not allowed to take any kind of project until and unless Sindh's demands were fulfilled.
- Sindh-Punjab agreement: This resolved the issue between the two provinces as nothing upstream could be built on Indus without the permission of Sindh as Sindh had supremacy over the Indus River basin according to the agreement.
- The arrangement was continued after partition in 1947 until a landmark treaty "Indus Water Treaty" between two arch-rivals Pakistan and India mediated by World Bank was signed in 1960. Consequently, two mega-dams, Mangla and Tarbela, were constructed besides extension of the canal network, diverting water from the Indus to the eastern side of the country. To accommodate the massive structural changes in the system in the wake of the Indus Water Treaty of 1960 a new arrangement for water share among provinces became inevitable. Thus, in 1991 another significant event happened when a **water apportionment accord** was signed among four provinces, agreeing to the scheme of distribution of water among the provinces.
- Indus Water Treaty: After partition of India in 1947, the intensity of water disputes shifted from intrastate to interstate level, where India and Pakistan were contesting their water rights against each other. The two states with the arbitration of World Bank were able to conclude a mutually agreed treaty in 1960. Although, this treaty settled the water conflicts between two hostile neighbors yet it became one of the determining factors in the post-treaty inter-provincial water conflicts in Pakistan as Pakistan lost its rights on three eastern rivers namely Sutlej, Bias and Ravi(Biswas, 1992).

- Water Apportion Accord: A major development in water management system of Pakistan occurred in 1991. The sharing of information by WAPDA with the Governors of all the four provinces and provincial governments as well as comprehensive negotiations among all the major stakeholders led to conclusion of Water Apportionment Accord.

Takeaways:

A. It ensures the protection of the existing utilization of canal water in each Province

B. It was recognized by all the stakeholders that water scarcity is a challenge for all and there is a need of building new water storages.

C. The issue of minimum sea escape below Kotri was also recognized. It recommended for further studies to avoid sea intrusion.

D. Through this accord a uniform procedure for sharing shortages as well as surpluses among all the provinces was charted out.

E. It was decided to establish an authority for the implementation of this accord. The authority would represent all the four provinces of Pakistan.

Challenges

- Sindh is skeptical about megaprojects on Indus River.
- This is the reason that in 2018, in-spite of hype and support by the rest of the country over the construction of **Basha dam Sindh** raised concerns and questions that it might reduce the environmental flows downstream Kotri which over the last decade have already been significantly reduced. Unfortunately, Sindh's stance has always been considered frivolous over their concerns to environmental flows, ship breaking industry, and mangrove forests degradation.
- Kotri downstream refers to the water flow below the Kotri Barrage, which is a dam on the Indus River in Sindh, Pakistan. The water flow downstream of Kotri is important for controlling seawater intrusion, maintaining ecological balance and supporting livelihoods of the people living in the delta region.
-

Causes:

1. Disputes over water apportionment: The lower riparian had fear of being deprived of their rightful share by upper riparian. The evidence of presence and persistence of this distrust is reflected in the various allegations levied by Sind on Punjab as well as by Baluchistan on Sind. Sind alleges Punjab of water theft while Baluchistan accuses Sind of not giving its share from Guddu and Sukhar Barrages.
- . As a counter strategy Punjab alleges Sind of not utilizing its proper utilization of the share of water which later receives. Punjab refers to 35MAF water wastage in Kotri downstream. The Sind considers this water escape as necessary for environmental protection in its coastal areas whereas Punjab demands for building of new dams and water reservoirs to stop this water escape into the ocean.
- on the issue of Kala Bagh Dam the three smaller provinces refused to submit before the federal government and Punjab.

2. distrust on state institutions are the factors responsible for the further aggravation of the problem.
-

3. Controversies Surrounding Interpretation of Water Apportionment Accord 1991

A. Construction if Additional Storages:The federal government and Punjab claimed that this clause referred to building of new reservoirs on river Indus including Kalabagh, Basha and Skardu and others. Contrary to this claim of Punjab and federal government Sind and KP expressed not only their concerns on these projects but also passed resolution in their respective assemblies against these projects.KP objected in particular on Kalabagh dam

arguing that it may lead to drowning of its cities like Nowshera and fertile lands of Mardan valley. Baluchistan and Sind supported KP's stance on Kalabagh dam.
B. Fresh Water Escape to Sea: w Kotri barrage. Although it was agreed by all the parties that each unit would ensure optimum and efficient use of its share of water, yet Sind and Punjab emerged with contesting figures on water escape below Kotri barrage. Punjab claimed that the volume of this water is 35MAF whereas Sind asserted that it was not more than 10MAF(Magsi, 2012).
C. Disagreements on water Storage Sharing
D. Greater Thal Projects: f construction of new canals in Punjab. Greater Thal Canal project with an objective to supply water from Indus to Thal desert like Jhang, Khushab, Bhakkar, layah and Muzaffargarh, Rainee-Thar Canal in Sind and Kachi Canal in Baluchistan as well as CRBLC in KP were objected by different stakeholders, where each canal is seen with suspicious eyes by other provinces except its own project. The most controversial among all these canals is that of Greater Thal Canal which is objected by Sind and Baluchistan. Sind and Baluchistan alleged that this project will enable Punjab to steal Indus waters
E. Chama- Jhelum link Canal Controversy: The roots of interprovincial water conflicts and ineffective water management system could be traced into Pakistan's external water disputes. One such example is that of Chashma-Jehlum link Canal Controversy. As per Indus Water Treaty (1960) Southern Punjab was deprived of water supplies due to establishment of Indian rights on the eastern rivers. To tackle water shortfall in Southern Punjab two link canals were constructed; Chasma-Jehlum and Tounsa-Panjnad. These canals supplied water from Indus to Southern areas of Punjab. These canal were constructed without framing any operating rules. When Water Apportionment Accord of 1991. Water Apportionment Accord (1991) determined the water share of each province; where Indus Basin was divided into three zones i.e. the Indus Zone, Jehlum-Chenab. Zone and Tributary Zone. It was agreed that Indus Zone would draw water from Indus River only, Jhelum-Chenab Zone from Jhelum and Chenab rivers whereas Tributary Zone from both Indus and Jhelum Chenab rivers. Punjab claimed its right on Indus waters as per paragraph 14e of the accord whereas Sind declared it as misinterpretation and argued that Punjab could not withdraw water from Indus in times of water shortage in Sind. Thus this controversy on interpretation of the Accord has also led to serious water management and distribution issues among the two federating units that also has its implications for the third i.e. Baluchistan.

Impacts

-

Solutions

A. Activating Council of Common Interest
B. Role of Senate
C. Need for a Fresh Water Accord
D. Improvement in Telemetry System
E. Water Conservation and Modernizing Irrigation System= infrastructure of canal , avoid water wastage
F. Improvement in Metrological department
G. Improvement in Institutional Structure; Irsa needs to be restructured, empowered

Issues of System loses: and Important Authorities

3. H**ow water availability is measured?**

- Water availability is measured through Falkenmark indicator that provide relationship between available water and the human population. 1700 m3 water stressed, 1000m3 is water scarce.
- Water Resources Vulnerability Index
4. Wapda

5. Isra (Indus River System authority)

A. lay down the basis for the regulation and distribution of surface waters amongst the Provinces according to the allocations and policies spelt out in the Water Accord;

B. review and specify river and reservoir operation patterns and periodically review the system of such operation;

C. coordinate and regulate the activities of the Water and Power Development Authority in exchange of data between the Provinces in connection with the guaging and recording of surface water-flows;

Explanation:- Actual observation and compilation of the data shall be the responsibility of the respective Provinces, Water and Power Development Authority and other allied organizations, while the process shall be monitored by the Authority;

D. determine priorities with reference to sub-clause (c) of clause 14 of the Water Accord for river and reservoir operations for Irrigation and hydropower requirements;

E. compile and review canal withdrawal indents asreceived from the Provinces on 5-daily or, as the case may be, on 10-daily basis and issue consolidated operational directives to Water and Power Development Authority for making such releases from reservoirs as the Authority may consider appropriate or consistent with the Water Accord;

Explanation:- The directives issued under this clause shall be binding upon Water and Power Development Authority and the Provinces, and shall be followed in letter and spirit.

F. settle any question that may arise between two or more Provinces in respect of distribution of river and reservoir waters; and

G. consider and make recommendations on the availability of water against the allocated shares of the Provinces within three months of receipt of fully substantiated water accounts for all new water projects for the assistance of the Executive Committee of the National Economic Council.

A. What is current water sharing method of Isra and how much provinces are satisifed by distribution

- Informed sources said the Sindh government would demand water distribution under para-2 of the 1991 water apportionment accord but the Irsa would to continue with three-tier formula for water distribution among the provinces to absorb water shortages in the ongoing Kharif season.
- The three-tier formula is now a combination of para 2 (dicieded shared), para 14(a) and historical uses of 1977-82.
- Sindh has been arguing that while putting in place the three-tier formula, Irsa had surpassed its mandate envisaged under the accord and started distribution contrary to the accord and devised its own formulas despite Sindh's objection through a meeting of the provincial committee of ministers.

B. History of Water distribution

- Under the 1991 water accord, the apportionment of water was made under para 2 of the agreement that fixed provincial shares.
- However, due to water shortages, this para is not currently in application for more than a decade, as Irsa with the involvement of federal and provincial governments put in place in 2002 a cascading water distribution share mechanism among provinces in the light of shortages.

Water Security

Indus Basin Irrigation System:

- The Indus Basin Irrigation System (IBIS) (figure 4.1) is a large, complex system of hydraulic infrastructure that has been developed incrementally over many decades (figure 4.2).
- It represents an estimated US$300 billion in investment.
- Before partition:when the total canal command area was around 10.4 million hectares. new irrigation systems were developed. Jinnah Barrage was completed in 1947; Kotri Barrage,

1955; Taunsa Barrage, 1959; Guddu Barrage, 1962; and Chashma Barrage, 1971, increasing the canal command area by 35 percent to 14 million hectares.
- Fundamental to the design and operation of the IBIS are a series of link canals that move water eastward from the mainstem Indus and the western tributaries to the eastern tributaries. The earliest link canals—the Upper Jhelum and the Upper Chenab links—expanded irrigation on the western Rechna and Dari doabs, respectively.
- IBIS water, which services 17.2 million hectares, is regulated through three major reservoirs, 16 barrages, two headworks, two siphons across major rivers, and 12 interriver link canals. The irrigable area consists of 44 canal commands:
- The IBIS is supply-driven rather than demand-driven: demand usually exceeds supply, and available water is "pushed out" through the distribution system according to largely fixed rules. IBIS operation is almost fully manual. There is no internal reregulating storage, very rudimentary control for farm-level water delivery, and despite considerable and ongoing investment and improvement, most of the extensive distribution network is unlined and leaky.

Water Policy Pakistan:

- 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 dialog, 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 interprovincial tensions around water sharing, the establishment of a **National Water Council** as proposed in the National Water Policy is fundamental. The 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 that guide cooperative basin planning as well as provincial water management

solutions

A. to Water CrisisConstruction of Dams
B. Management of Water Resources
C. Political ownership of Challenge
D. Policy, reforms and change
E. Recycling of Wastewater
F. Increase agriculture efficiency
G. Water metering/Pricing
H. Formation of Ground Water Regulation Authority(Water Scarcity in Pakistan by Dr. Muhammad Ashraf)
I. Mass awareness campaign

Water Resources Management

1. Strengthen Water Data, Information, Mapping, Modeling, and Forecasting
- Clarify federal legal mandates for water information collation and sharing.
- Strengthen provincial legal frameworks for land-use planning that consider flood risks.
- Establish an implementation framework for the National Water Policy, with clear roles and responsibilities for water data and information.
- Develop standards and guidelines for flood risk mapping and a policy framework for floodplain zoning.
- Strengthen federal capacity for water data management, modeling, and forecasting, including the use of Earth Observations.
- Strengthen provincial capacity for monitoring and reporting water distribution and use.
- Strengthen federal capacity for flood risk mapping and flood forecasting.
- Build provincial capacity for floodplain zoning.
- Expand national and provincial hydromet networks, including for cryosphere and groundwater monitoring.
- Establish interoperable national and provincial water information systems.

2. Establish a Multistakeholder Process of Basin-Scale Water Resources Planning
- Establish a sound legal mandate for federally led cooperative basin planning.
- Strengthen provincial legal frameworks for water resource planning.
- Establish an implementation framework for the National Water Policy that articulates roles, responsibilities, time frames, and processes for basin planning.
- Establish a National Water Council, as proposed in the National Water Policy, to provide strategic framing for cross-jurisdictional basin planning.
- Strengthen the federal government capacity for river basin management (either within the Indus River System Authority (IRSA), the Pakistan Water and Power Development Authority (WAPDA), or by establishing a new authority), in cooperation with provincial governments. -
- Establish consultative processes for effective and broad stakeholder input.

3. Establish Provincial Water Planning and Intersectoral Water Allocation Mechanisms
- Establish clear legal property rights (licenses) for water— separate from land— and the legal requirement to maintain public register of water licenses.
- Develop and implement provincial water policies to establish sectoral priorities and to define allocation processes
- Incrementally transform provincial irrigation departments into water resources management agencies with broad responsibilities, including environmental management.
- Establish robust participatory processes to guide water allocation planning.

4. Accelerate Agricultural Water Productivity Increases
- Scope legal provisions to support pricing and trading of water rights.
- Phase out subsidies for wheat and sugarcane.
-Liberalize agricultural commodity markets.
- Support adoption of water efficiency technologies and diversification to higher-value crops.
- Strengthen capacity for economic modeling within federal and provincial governments.

- Improve on-farm water management through farmer training and awareness raising.
- Introduce methods of rice cultivation that require less water.
- Increase investment in agricultural research.

5. Adopt Conjunctive Planning and Management of Surface and Groundwater

- Establish provincial-level regulatory frameworks for groundwater access and for management and regulation.
- Develop district-level conjunctive water management plans that focus on building drought resilience.
-Strengthen the capacity of provincial water resource management departments for groundwater management and conjunctive planning.
- Strengthen water user associations for local monitoring and management of groundwater resources in line with agreed conjunctive water management plans.
- Build federal capacity for basin-scale modeling and analysis of surface–groundwater interactions.

6. Construct Limited New Storage and Review Reservoir Operations

- Review and revise reservoir standard operating procedures, based on detailed modeling and analysis.
- Strengthen federal capacity to enable periodic reviews of operating procedures and to support a multiobjective approach to operations.
- Secure finance for construction of Diamer Bhasha Dam and associated power generation and distribution infrastructure (if HEP justifies the expense).

Water Services Delivery

1. Modernize Irrigation and Drainage and Improve Operations

- Revise the Provincial Irrigation and Drainage Authorities Act to clarify roles and responsibilities in irrigation management between irrigation and drainage authorities and provincial government departments.
- Replace warabandi with new water sharing rules based on economic efficiency and farmer equity.
- Reform irrigation tariffs to reflect realistic operations and maintenance (O&M) costs.
- Strengthen the capacity with provincial government water resources management departments to oversee irrigation and drainage authorities and performance of water user associations and farmer organizations.
- Strengthen water user associations for improved system operation and improved abiana collection.
- Reform governance of water user associations and farmer organizations to prevent elite capture.
- Modernize irrigation systems, including new hydraulic control structures and lining of canals in waterlogged and saline areas.
- Automate control of hydraulic structures using real-time data acquisition systems.
- Systematically improve drainage infrastructure.

2. Reform Urban Water Governance and Close the Infrastructure Gap

- Establish legal mandate for regulatory oversight of urban water service provider performance.
- Strengthen the regulatory framework for pollution discharges.
- Rationalize overlaps in the provincial policy frameworks and align with local government legislation.
- Develop and disseminate standards for urban water service delivery, and link service tariff increases to service quality.
- Strengthen and empower urban water service providers.
- Establish independent regulator to oversee service provider performance and to help reduce political interference.

- Establish an enabling environment for increasing private sector participation in urban water sector.
- Greatly increase the capacity and performance of wastewater treatment.
- Improve O&M of existing major distribution infrastructure.
- Increase the coverage and reliability of urban water meters.
3. Improve Rural Sanitation
- Establish clear legal mandate for the provision of rural sanitation services.
- Establish provincial standards and targets for rural sanitation services.
- Strengthen the capacity and increase the financing of provincial government departments responsible for rural sanitation.
- Establish appropriate district-level institutional arrangements to engage with communities in infrastructure improvement.
- Establish appropriate mechanisms to ensure sustainable revenue base for O&M costs.
- Monitor and report progress toward rural sanitation targets.
- Invest in public infrastructure for rural sanitation services including wastewater collection and basic treatment and disposal at village level.

Water-Related Risk Mitigation

1. Improve Understanding and Management of Climate Risks to the Lower Indus and Delta -
- Develop long-term plans for sustainable management of the Indus Delta.
- Strengthen the technical capacity of water and environmental management agencies in Sindh for climate change impact assessments and mitigation planning.
- Resource relevant agencies for effective implementation of management plans.
- Assess the feasibility of barrier groundwater wells to slow sea water intrusion.
2. Strengthen Planning and Management of Water–Energy Interactions
- Establish provincial-level regulatory frameworks for groundwater access and management.
- Analyze the synergies and antagonisms between current national energy and water policy frameworks to inform policy implementation.
- Increase coordination between government departments at federal and provincial levels
- Strengthen capacity for joint energy–water analysis that considers economic and environmental outcomes.
- Expand solar and wind power investment where sensible.
- Explore feasibility for small-scale hydro on irrigation canals.
- Continue major HEP investment with run-of-river focus.
3. Improve Understanding and Management of Basin-Scale Sediment Dynamics
- Develop a management plan to guide long-term, basin-scale sediment management.
- Strengthen capacity in relevant technical institutions for multiple aspects of sediment monitoring, modeling, and analysis.
- Ensure that new reservoir designs and barrage rehabilitation projects consider sediment-related risks to structural safety and operational.

Most Urgent Issue

Water Services Delivery

1 Irrigation and drainage services
2 Urban governance and infrastructure
3 Rural sanitation

Moderate Urgent Issue

Water Resources Management

1. Data, information, and analysis
2. Participitory basin planning
3. Provincial planning and allocation 4 Agricultural water productivity 5 Conjunctive water management 6 New dams and revised operations

Less Urgent

Water-Related Risk Mitigation

1. Climate risks to the delta
2. Water-energy nexus
3. Basin sediment management

Indus Water Treaty

- ISLAMABAD: In a major win for Pakistan, the Permanent Court of Arbitration (PCA) in The Hague on Thursday rejected India's objections to its assumption of jurisdiction in a dispute between the neighbouring countries over the Kishanganga and Ratle Hydroelectric projects, pursuant to the Indus Waters Treaty.

-

Islamabad initiated legal proceedings on Aug 19, 2016 by requesting the establishment of an ad hoc Court of Arbitration, pursuant to Article IX of the Indus Waters Treaty.

- Indus Water Treaty:

- On Jan 25, 2023, India notified Pakistan through the Indus Commission of its intention to modify the Indus Waters Treaty. This reflected a hardening of India's position and an effort to take advantage of Pakistan's preoccupation with its domestic political turmoil and economic crisis.
- Pakistan has long disputed the construction of the 330 megawatt Kishanganga hydroelectric project on the Jhelum river and plans to construct the 850 MW Ratle Hydroelectric Project on the Chenab river in occupied Jammu and Kashmir.
- This dispute has figured for decades in bilateral talks and meetings of the Permanent Indus Commission. Because a resolution proved elusive, in 2016 Pakistan approached the World Bank, which brokered the treaty and is also a signatory, to appoint an ad hoc Court of Arbitration to deal with the dispute, a provision under the treaty.
- While India completed the Kishanganga project in 2018, the bank took six years to activate the court as well as a neutral expert, sought by India. Both dispute settlement methods are sanctioned by the treaty. Two days before the first court hearing at the Hague on Jan 27, which India boycotted, Delhi served notice on Islamabad that it would unilaterally amend the treaty citing Pakistan's "intransigence in handling disputes"
- This indicated Delhi's effort to avoid any court process and intent to bar third-party intervention in disputes by the proposed treaty modification. It asked Islamabad to respond in 30 days to its 'notice'.

Salient Features of Indus Water Treaty:

- The Indus Water Treaty (IWT) is a bilateral water-sharing agreement signed between India and Pakistan in 1960, under the supervision of the World Bank1234.
- The treaty governs the use of the Indus River and its tributaries, which are crucial water sources for both countries
- The treaty divides the Indus River and its tributaries into three Eastern Rivers and three Western Rivers, which are allocated to India and Pakistan respectively, with some exceptions1345. The IWT also establishes a mechanism for resolving disputes and provides for cooperation between the two countries on developing hydroelectric power and implementing irrigation projects.
- According to the Indus Water Treaty, the water quality of the Indus River and its tributaries is monitored by the Permanent Indus Commission, which has a Commissioner from each

country. The Commission is responsible for cooperation and information exchange between the two countries regarding their use of the rivers.
- The Treaty also provides for the settlement of any questions, differences or disputes that may arise between the two countries concerning the interpretation or application of the Treaty provisions. These are to be handled by different mechanisms, such as a Neutral Expert or a Court of Arbitration, depending on the nature and severity of the issue.
- The World Bank, as a signatory to the Treaty, has a limited and procedural role in facilitating the designation of individuals to fulfill certain roles in these mechanisms when requested by either or both of the Parties. The World Bank is not involved in the design or operation of any hydroelectric power plants on the Indus system of rivers.

Challenges to the Treaty:

- According to the Indus Water Treaty, the water quality of the Indus River and its tributaries is monitored by the Permanent Indus Commission, which has a Commissioner from each country. The Commission is responsible for cooperation and information exchange between the two countries regarding their use of the rivers12
- The Treaty also provides for the settlement of any questions, differences or disputes that may arise between the two countries concerning the interpretation or application of the Treaty provisions. These are to be handled by different mechanisms, such as a Neutral Expert or a Court of Arbitration, depending on the nature and severity of the issue12
- The World Bank, as a signatory to the Treaty, has a limited and procedural role in facilitating the designation of individuals to fulfill certain roles in these mechanisms when requested by either or both of the Parties. The World Bank is not involved in the design or operation of any hydroelectric power plants on the Indus system of rivers

Dams in Pakistan

How many dams are in Pakistan?
- Three large dams constructed in the 1960s and 1970s— the Tarbela on the Indus, the Mangla on the Jhelum, and the Chashma on the Indus—account for most of the built water storage in Pakistan (WAPDA 2016).

What is procedure and cost of construction of Dam?
- The estimated cost for Diamer-Bhasha is $14 billion, but it could be higher due to inflation, debt servicing, and environmental extremities.

What types of Dams are feasible for water storage?
- Small dams are usually cheaper and easier to construct than big dams, but they may also require more maintenance and have a shorter lifespan1.
- Small dams may have less impact on the natural flow and sediment transport of the river than big dams, but they may also divert more water from the river for irrigation or other uses.
- Small dams may have less impact on the aquatic and riparian ecosystems than big dams, but they may also fragment the river habitat and affect fish migration more than big dams23.
- Small dams may have less impact on the social and cultural aspects of the river communities than big dams, but they may also provide less benefits in terms of flood control, water supply, hydropower, and recreation23.

What are capacities of Dams in Pakistan?
- Designed primarily to supply water for irrigation, the original combined live storage capacity of these dams was 19.4 billion cubic meters (Tarbela, 12 billion cubic meters; Mangla, 7.3 billion cubic meters; and Chashma, 0.87 billion cubic meters). Ongoing sedimentation has, however, decreased capacity by around 1 percent per year to 15 billion cubic meters by 2007

How Dams are useful for Pakistan? Reasons f delay?

- Dams are useful for Pakistan in many ways, such as:
They provide water storage for irrigation
(*The storage capacity provided by the largest Indus River in Pakistan is averaging at 137 million acre-feet. The storage capacity of the longest river Nile is much higher. The average annual flow rate in the Indus River is higher than the Nile but the Nile has 132 million acre-feet usable storage capacity. The difference is due to water management strategies.)*, domestic use, and drought mitigation. Pakistan is an agricultural country that depends on water resources for crop production. Dams can store water during the monsoon season and release it during the dry season to meet the water demand of the farmers and the people. Dams can also help prevent water scarcity and improve water security in the future12.
- They generate hydropower electricity for industrial and domestic use. Pakistan faces a chronic energy crisis that affects its economic growth and social development. Dams can harness the potential energy of water to produce clean and renewable electricity that can reduce the dependence on fossil fuels and lower the greenhouse gas emissions. Dams can also provide peak power supply, load balancing, and grid stability123.
- They control floods and protect lives and properties. Pakistan is vulnerable to floods that cause massive damage to infrastructure, agriculture, and human settlements. Dams can regulate the flow of water and reduce the risk of flooding downstream. Dams can also protect the river banks from erosion and sedimentation123.
- They create recreational and tourism opportunities for the local people. Dams create reservoirs that offer scenic views and aquatic activities, such as boating, fishing, swimming, and camping. Dams can also support the development of local businesses, such as hotels, restaurants, shops, and transport services. Dams can also preserve the cultural and historical heritage of the river communities14.

Adverse effect of Dams
- They alter the natural flow and sediment regime of the river, which can affect the aquatic and riparian ecosystems, biodiversity, and fisheries. Dams can reduce the downstream flow of water and nutrients, trap the upstream sediment and nutrients, and change the temperature and oxygen levels of the water. These changes can disrupt the habitat and migration of fish and other aquatic organisms, reduce the spawning and breeding grounds, and increase the risk of invasive species and diseases12.
- They emit greenhouse gases that contribute to global warming and climate change. Dams can produce methane and carbon dioxide from the decomposition of organic matter in the reservoirs, especially in tropical and subtropical regions. Methane is a more potent greenhouse gas than carbon dioxide, and its emission from dams can be significant. Dams can also affect the carbon cycle by altering the transport and storage of carbon in the river basin12.
- They displace people and communities that depend on the river for their livelihoods and culture. Dams can inundate large areas of land that are used for agriculture, grazing, forestry, or settlement. Dams can also affect the access to water, land, and other resources for the downstream communities. Dams can cause social and economic disruption, loss of cultural heritage, human rights violations, and conflicts among the affected people13.

Solutions to counter adverse effects of Dams in Pakistan
- Implementing environmental flow regimes that mimic the natural variability of the river and maintain the ecological functions and services. Environmental flows can be designed to provide adequate water quantity, quality, timing, and duration for the downstream ecosystems and users. Environmental flows can also help restore the sediment balance, prevent reservoir siltation, and reduce greenhouse gas emissions12.
- Installing fish passage facilities that allow the upstream and downstream movement of fish and other aquatic organisms across the dam. Fish passage facilities can be classified into three types: fish ladders, fish lifts, and fish locks. Fish ladders are artificial channels that provide a gradual ascent for fish over the dam. Fish lifts are mechanical devices that lift fish from the lower to the upper level of the dam. Fish locks are chambers that alternately fill and empty with water to transport fish across the dam12.

- Enhancing the riparian and aquatic habitats in the reservoir and downstream areas that have been degraded or lost due to the dam. Mitigation measures can include creating or restoring wetlands, floodplains, islands, gravel bars, riffles, pools, and other features that provide shelter, food, and spawning grounds for the biota. Mitigation measures can also include controlling invasive species, pollution, and overexploitation of resources.

Some of the examples of successful dam mitigation projects are:
- The San Vicente Dam Raise Project in San Diego County, California, which increased the height of the existing dam by 35 m and the storage capacity of the reservoir by 200 million m3. The project improved the water supply reliability, flood protection, and emergency response for the region. The project also included environmental enhancements, such as habitat restoration, erosion control, and fish passage improvements1.
- The Three Gorges Dam Ecological Compensation Project in China, which allocated funds to restore the ecological environment and protect the biodiversity in the reservoir area and downstream regions of the dam. The project involved afforestation, soil conservation, wetland protection, water quality monitoring, and ecological compensation payments to the affected communities2.
- The Marmot Dam Removal Project on the Sandy River in Oregon, which eliminated a 14 m high and 50 m wide concrete dam that blocked fish passage and altered sediment transport. The project restored the natural river processes and functions, improved habitat connectivity and quality for salmon and steelhead, and reduced the risk of dam failure3.

What are challenges to construct Dams in Pakistan and reasons p?
- Environmental and ecological concerns: Building dams can have significant environmental and ecological impacts, such as altering the natural flow and sediment regime of the river, affecting the aquatic and riparian ecosystems, biodiversity, and fisheries, emitting greenhouse gases that contribute to global warming and climate change, and displacing people and communities that depend on the river for their livelihoods and culture.
- Political and financial challenges: Building dams requires significant investment, and the political and financial challenges associated with it can be daunting. For example, Pakistan has faced difficulties in securing funds for the Diamer-Bhasha dam for years, due to its location in disputed Kashmir and the reluctance of international donors. China has stepped in to bankroll part of the project, but the estimated cost of $14 billion might be too low, considering the inflation, debt servicing, and environmental externalities23.
- Public perception of dams in Pakistan: The public opinion on dams in Pakistan is divided, with some supporting them as a symbol of progress and independence, and others opposing them as a source of social and environmental injustice. The debate on dams is often influenced by jingoistic overtones, emotional appeals, and misinformation. The public awareness on the benefits and costs of dams, as well as the alternatives to dams, is low24

What are solution to resolve these challenges?
Delay in Construction of Dam?
- The Implementation Committee of Diamer Bhasha and Mohmand Dams (ICDBMD) constituted by the Supreme Court of Pakistan Thursday identified causes for the delay in construction of both key dams, including funding issues. The cost of both projects has been estimated at $ 17 billion.
- Corruption and red tape-ism: Corruption and red tape-ism are not only ethical and legal issues, but also economic and developmental issues. They can undermine the public trust and confidence in the government and the institutions responsible for dam projects. They can also discourage the participation and contribution of the private sector, civil society, and international donors. Corruption and red tape-ism can create a vicious cycle of poor governance, low performance, and high risk in dam projects .
- Negligence on the part of government: Negligence on the part of government can reflect a lack of political will, leadership, and coordination among the relevant stakeholders. It can also indicate a failure to address the legitimate concerns and demands of the affected people and

regions, such as land acquisition, compensation, resettlement, environmental protection, and benefit sharing. Negligence on the part of government can result in missed opportunities, wasted resources, and lost benefits for the country .

- Natural disasters: Natural disasters are unpredictable and unavoidable events that can pose serious challenges and threats to dam projects. They can cause physical damage, human casualties, financial losses, and operational disruptions. They can also exacerbate the existing vulnerabilities and inequalities in the society. Natural disasters require effective preparedness, response, and recovery measures to minimize their adverse impacts and enhance the resilience of dam projects .

-Financial difficulties faced by contractor Many contractors delayed or stopped the construction activities at site only because of delay or shortage of funds. It is true that main contractor plays role for from initial stage to final stage of the project and it is also true that only contractor plays role in execution of the project (Frimpong et al., 2003).Economic advisors also calculated that the cost of the Diamer-Bhasha dam was predicted at $12.6 billion in November 2008. An amount of Rs 27.824 billion is required for the acquisition of land & resettlement of the people to be affected in the wake of the construction of the dam. Under the proposed project, Rs 10.76 billion will be invested for the acquisition of agriculture-barren land, tree & nurseries and Rs 1.638 billion to be used for properties and infrastructure, Rs 8.8 billion for establishment of 9 model villages, Rs 62.119 million for pay & allowances for administrative arrangements, and Rs.17.7 million for contingent administrative expenses.

- Disputes on site Disputes between labors and sometimes disputes between management and labors delay the approved time frame of the project. Many projects are delayed because of disputes at the construction sites which takes time to resolved and with this project time duration exceeds from approved one (Alaghbari et al.,2007).

- Poor site management Poor site management factor delays the construction projects because daily routine activities or work is not properly managed at sites and this factor includes poor management by project engineers and contractors (Le-Hoai et al.,2008). Mostly this factor take place when the project engineer quit his job and that post remain vacant for long period.

- Unexpereinced contractor Appointment of unexperienced and incompetant contractor factor causes delay in consttruction of dam projects because contrcators is not well experineced in construction of dams as well as he has no compitetant staff and skilled labour. Appoitment of contractor on favoustism basis also can causes the delay in consruction projects (Alaghbari et al., 2007).

- Rapid changes in design For rapid and frequent changes in design which causes delay in construction of dam projects for that client and consultant are responsible. Frequent design changes delay the project activities which can causes delay in completion of project within time frame (Aziz et al., 2013).

- Mistake in Time estimation Mistakes in estimation of project duration causes because of lack of experineced enginners or planners of consultant and improper estimation of completion period of project. Estimation of project length is based on resources and their output (Sweis et al., 2008).

- Shortage of skilled labor Pakistan is develping country and many projects are on going at a time so construction industry is facing problem of shortage of skilled labour. Construction of dam projects are mostly in hilly and remote areas so it availibilty of skilled labour is cruicial problem and which causes delay in completion of project in given specific time period (Sambasivan et al.,2007)

- It is also said that during the previous 7 years, India has lobbied heavily by diplomatic channels to discourage foreign support for the project; leading ADB, World Bank and even Kuwait Fund for Arab Economic Development to withdraw funding pledge. On 14 November 2017, Pakistan dropped its bid to have the dam financed under CPEC framework as China placed strict conditions including on the ownership of the project.

Solutions:

- Strengthening the governance and accountability of dam projects: Improving the transparency, integrity, and efficiency of the planning, financing, procurement, and execution

of dam projects can help reduce corruption and red tape-ism. Establishing clear roles and responsibilities, enforcing rules and regulations, monitoring and evaluating performance, and ensuring public participation and oversight can help enhance the governance and accountability of dam projects12.
- Building political consensus and social acceptance of dam projects: Addressing the political and social conflicts and controversies surrounding dam projects can help overcome the negligence on the part of government. Developing a national water policy and strategy, resolving inter-provincial and regional disputes, engaging with the affected people and regions, and ensuring fair compensation and benefit sharing can help build political consensus and social acceptance of dam projects13.
- Increasing the resilience and adaptation of dam projects to natural disasters: Preparing for and responding to the natural disasters that can affect dam projects can help mitigate their impacts and risks. Conducting risk assessments, designing disaster-resistant structures, implementing contingency plans, providing emergency relief, and restoring normal operations can help increase the resilience and adaptation of dam projects to natural disasters2 .

Diamer Basha Dam
- Diamer Bhasha Dam

Which institute deals with Dams construction?
- According to the web search results, the Water and Power Development Authority (WAPDA) is the main authority responsible for constructing dams and hydropower projects in Pakistan12. WAPDA has started construction on two major hydroelectric projects: Mohmand in Khyber Pakhtunkhwa and Diamer-Bhasha in Gilgit-Bal

Dams construction in CPEC project?

How much Pakistan has capacity to Produce hydroenergy and How Dams can solve energy crisis in Pakistan
- Experts calculated that approximately 22,000 to 24,000 megawatt (MW) electricity is needed in Pakistan. This demand grows up to 5 percent yearly. It means 1,000 or 1,200MW shortfall is added. Unluckily, the country has never been able to generate to greater than 18,000MW energy. The previous government stated to produce almost 24,000MW electricity in Pakistan. But even National Transmission and Dispatch Company (NTDC), which is an institution of the government, does not confirm it. Different energy sources also mention that there is a difference of 6,000ME between the production and the transmission of power. It is expressed in the form of load-shedding across Pakistan.
- Diamer-Bhasha Dam would, produce 4,500MW of electricity by environmentally clean hydropower generation; store an extra 8,500,000 acre feet of water for the country that will be used for irrigation and drinking; extend the life of Tarbela Dam located downstream by 35 years; and control flood damage by the River Indus downstream during high floods.