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Pakistan and Water – A Situation in Crisis

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Introduction

"Thousands have lived without love, not one without water". These timeless words from W. H. Auden's poem, *First things First*, stand truer today than ever before for Pakistan. The current water crisis combined with the rising effects of climate change will impact many countries worldwide. Yet Pakistan and South Asia are more likely to be adversely affected by these conditions than other regions[1].

A study by the University of Oxford found that water related crises, e.g. droughts and floods, are costing the global economy hundreds of billions of dollars in annual loss[2]. Pakistan is now only 30 years away from becoming a water scarce country. The effects on our agricultural, industrial, domestic sectors and resultantly on our economy will be devastating.

Currently, conservative approximations on the cost of various water-related risks estimate that 4 percent of our GDP is used (or $12 billion) per year. The majority of these costs relate to poor water supply and sanitation[3]. A catalogue of water scarcity solutions by 2030 Water Resources Group states that the "availability of water at the right time, at the right volume and at the right price is an essential underpinning of economic growth and development" [4].

According to a recent World Bank report, water security in Pakistan – defined by how water is managed and used based on social, economic, and environmental outcomes – is at risk from a multitude of problems. Pakistan suffers from poor water resource management, poor water service delivery, unsafe domestic water supply and inadequate sanitation services. Crucially, impending long-term risks are not recognised or are not acted upon effectively[5].

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[1] Sadoff, C.W, et al. *Securing Water, Sustaining Growth: Report of the GWP/OECD Task Force on Water Security and Sustainable Growth*, 2015, p.180
[2] Ibid. pp.19-20
[3] Young, W. Anwar, A. et al., *Pakistan: Getting More from Water,* World Bank, 2019, p.xv
[4] Tindale, M., and Sagris, T., *Managing Water Use in Scarce Environments: A Catalogue of Case Studies,* 2030 Water Resources Group 2013, p.18
[5] Young, W. Anwar, A. et al., *Pakistan: Getting More from Water,* World Bank, 2019, pp. xv-xvi

Numerous books, reports, research documents, and articles have been published on the crisis that we are likely to face in full effect by 2050. Yet there have been hardly any calculated changes put in place or visible efforts to amend policies and practices that are exacerbating the situation. It is time for the government to implement strategies from the plethora of current research available.

The water crisis in Pakistan is affected by 3 main factors:

1. **Water Usage**: waterways are being polluted after water used in all sectors is saturated with harmful chemicals and bacteria. By far the greatest wastage of water lies in the agricultural sector.
2. **Water Storage**: the lack of sufficient storage reservoirs and the fast depletion of natural aquifers is a huge cause for concern.
3. **Water and Conflict**: India and Pakistan share joint ownership over the Indus River and its tributaries under the Indus Waters Treaty 1960. However, recent inflammatory calls for scrapping the treaty and threats by the Indian government to cut off the water supply are alarming. Disagreements between provinces are also preventing progress in water-related sectors.

This report addresses each of these sections and solutions are put forward that may enable us to safeguard the future of our precious water resources.

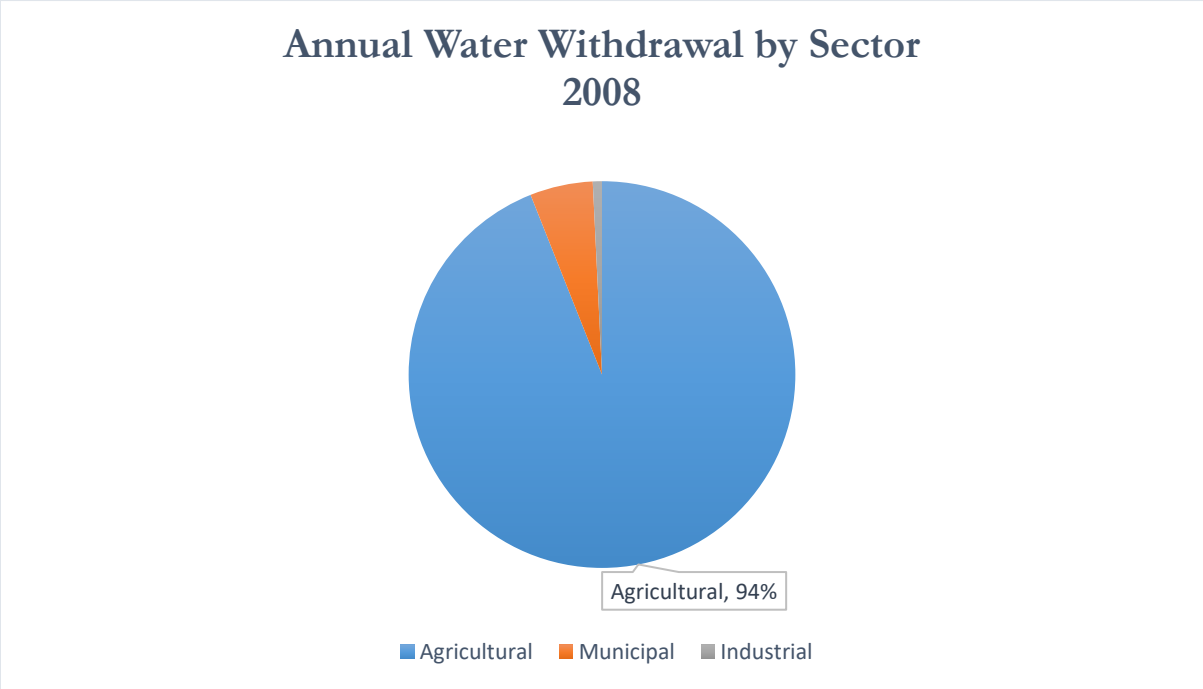
Though some solutions may prove to be unfeasible, it is difficult to propose any concrete changes due to the lack of available data on existing water resources. This has remained a significant hurdle and therefore data collection must become streamlined. This will lead to greater understanding of the unique problems that freshwater resources face across all regions in Pakistan and subsequently, bring forth ways to solve these problems.

Nonetheless, initial steps must be taken to at least consider the possibilities available in order to fight Pakistan's growing water scarcity.

Water Usage

Pakistan has the highest water intensity rate in the world. This is the amount of water in cubic metres used per unit of GDP[6]. In the National Water Policy 2018, the federal government and provincial institutions recognised that with rising temperatures, the consumption of water in all sectors – domestic, industrial, and agriculture – is set to increase[7]. Climate change poses a direct threat to the demand for water and emphasises the necessity for its efficient use. 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. Compare this to the global average for agriculture which lies at around 70 percent, according to the UN Food and Agriculture Organization (FAO). Clearly, what remains to be tackled most urgently lies mainly within the agricultural sector, however, it is pertinent to briefly touch upon the remaining sectors' water usage and their consequent water pollution.

Graph 1: Annual Water Withdrawal by Sector



[Source: FAO]

Domestic sector usage:

A World Resources Institute blog observes that fresh water in India is extracted on a linear model as opposed to a cyclical model for consumption[8]. This can be appropriately applied to the situation in

[6] Baloch S. M., *Water Crisis: Why is Pakistan running dry?*, DW, 7th June 2018, www.dw.com/en/water-crisis-why-is-pakistan-running-dry/a-44110280, [accessed 31st May 2019]
[7] Ministry of Water Resources, *National Water Policy*, 2018, p.15
[8] Boggaram V., and Goswami S., *From Waste to Watts: How Sewage Could Help Fix India's Water, Energy and Sanitation Woes*, WRI, 22nd March 2017, www.wri.org/blog/2017/03/waste-watts-how-sewage-could-help-fix-indias-water-energy-and-sanitation-woes [accessed 31st May 2019]

Pakistan as well, where water is continuously extracted, used, and disposed of. In this regard, new technologies allow for the treatment and subsequent reuse of raw sewage for a multitude of purposes. To cover the costs of such a venture, sludge-to-energy systems can be used to make wastewater treatment financially feasible and provide a sustainable form of renewable energy - these can also be built into existing treatment plants. However, at present wastewater treatment in Pakistan stands at less than 1 percent.[9] Pakistan also ranks 5th in the world for countries that have a total population lacking adequate or any sanitation. A World Bank report argues that major infrastructure investment will be required in order to tackle the growing issues of environmental pollution and the dangerous impact on public health[10].

Table 1: Top 5 Countries for people at risk of water insecurity[11]

Rank	**Shortage Index:** total population at risk of frequent water shortage	**Water & Sanitation Index:** total population lacking sanitation
1	China	India
2	**Pakistan**	China
3	India	Nigeria
4	Bangladesh	Indonesia
5	Nepal	**Pakistan**

The city of Hong Kong for the past 50 years has been providing seawater to its citizens free of charge for flushing and other household demands. Moreover, 22 percent of total municipal water demand is met by seawater. Using this instead of freshwater has also led to less energy consumption and it does not require intensive treatment as the end product has "limited public health risks". Replacing normal pipes with non-corrosive ones has limited the negative effects of saltwater on the sewerage system but it is important to bear in mind that reclaiming used seawater becomes very difficult due to high levels of salinity[12]. A project of this nature to supply residents of Karachi or other coastal cities and towns in Pakistan should be considered, particularly since lack of basic sanitation facilities is a growing concern.

According to an International Monetary Fund (IMF) report, there is a largescale issue of inadequate tariff and cost recovery in the domestic sector. These tariffs have not been revised for several years and their collection ranges from 20 – 80 percent in various cities[13]. Effective cost collection can

[9] Ibid.
[10] Young, W. Anwar, A. et al., *Pakistan: Getting More from Water,* World Bank, 2019, p.135
[11] Sadoff, C.W, et al., 2015, p.107
[12] Tindale, M., and Sagris, T., *Managing Water Use in Scarce Environments: A Catalogue of Case Studies,* 2030 Water Resources Group 2013, pp.102-103
[13] IMF, *Issues in Managing Water Challenges and Policy Instruments: Regional Perspectives and Case Studies,* 2015, p.13

contribute positively to the government budget and allow for spending on upgrades to water infrastructure and improved sanitation conditions. This must become a priority.

A further possibility beyond cost collection is the introduction of tiered water rates for users who consume different amounts of water. This could be gradually applied to major cities in Pakistan – as it has been applied in Seattle in the USA[14]. It could prove to be an effective method to reduce wasteful practices in homes and reduce water consumption, without targeting those unable to afford an indiscriminate raise in the price of water. Any consideration of this method must involve a thorough investigation into the necessary consumption of water by households along with *actual* consumption at present.

Industrial sector usage:

Pakistan, like many countries in Asia, relies heavily on energy generated from hydropower or thermal resources such as coal, oil, or natural gas. However, both these sources of power require very large quantities of cooling water. The thermal sector is heavily dependent on steam production and water for steam cooling – it provides around 65 percent of the country's energy. Nuclear power plants require even more cooling water than other forms of power generation. Higher temperatures as a result of climate change will mean more water is required for these purposes[15]. The Asian Development Bank (ADB) noted that "not one Asian developing country has seriously assessed the current and future water requirements of its energy sector"[16].

Although renewable energy is the future, the facts remain that most forms of renewable power generation e.g. nuclear, and solar thermal plants require more water use for cooling purposes than an ordinary coal-fired power station[17]. The water used for generating this energy does not get polluted to a large extent and is returned for reuse, yet the vast volume required and the time it takes to be deposited back into rivers and canals is not sustainable in a future with looming water scarcity. For the energy sector, the government should be encouraged to invest in power schemes that require less intensive water usage, for example, wind energy in coastal areas. These should also be encouraged through subsidies and private sector investment. Equally, multipurpose dams with hydropower capabilities should be constructed that allow for both longer days of water storage and sustainable energy generation.

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[14] Tindale, M., and Sagris, T., *Managing Water Use in Scarce Environments: A Catalogue of Case Studies,* 2030 Water Resources Group 2013, p.83

[15] Parry J. E., et al., *Making Every Drop Count: Pakistan's growing water scarcity challenge*, IISD, 29th September 2016, www.iisd.org/blog/making-every-drop-count-pakistan-s-growing-water-scarcity-challenge [accessed 31st May 2019]

[16] Asian Development Bank (ADB), *Asian Water Development Outlook,* 2007, pp.9-10

[17] Waughray D., *Why Worry About Water? A Quick Global Overview,* WRG, 10th November 2010, www.2030wrg.org/why-worry-about-water-a-quick-global-overview/ [accessed 31st May 2019]

Pollution of waterways

Other areas of industry where water is used extensively are the textile and leather sectors. The agricultural sector is also a repeat offender with its widespread use of harmful pesticides and fertilisers. These sectors are crucial contributors to the economy; however, they also cause large scale pollution of the country's rivers and canals[18].

The Pakistan government's Vision 2025 puts forward several important initiatives to be completed by the set date. Under the heading for water crisis, the pollution of reservoirs and waterways is recognised as a serious threat with the major sources of contamination originating from industrial areas and urban settlements. Most of this waste directly pollutes the Ravi and Chenab rivers resulting in water-borne diseases as the most common form of infection to affect the national populace[19]. Studies have shown that a shocking 50 percent of all river pollution in Pakistan originates from the Ravi[20]. Environmental laws are already in place yet there is little to no enforcement of these laws by the authorities.

In an effort to combat this pollution and excessive water use, the World Wildlife Fund (WWF) launched a campaign with small to medium enterprises in Punjab to improve resource efficiency and enhance the capacity of the textile and leather sector to reduce their water use by 10 percent. These small-scale projects, though highly commendable, are not enough to prevent the widespread pollution of waterways on a national scale. The authorities, as is their remit, must fine those in violation of existing laws.

In an effort to curb the discharge of wastewater, Spain applied a 'Waste Water Reclamation Levy' which encouraged industries to treat wastewater on site, rather than have to pay for waste discharges into the river system. This also helped reduce the pressure on the public sewer system and minimised the risk of river pollution[21]. The success of these projects in Pakistan rely on strict enforcement – this has already proved difficult.

The Indian High Court also ordered zero discharge into river and groundwater systems by the textile industry. This led to reduced demand on the River Bhavani and 96 percent of the water reclaimed using treatment plants was resupplied to the industry. However, these positive outcomes were achieved through high financial and energy costs[22].

These are options that need to be discussed in Pakistan while bearing in mind the unique difficulties faced by the Indus river basin. As such, they should be used to inspire similar initiatives that are suitably shaped to tackle the issues faced across different provinces and regions. Such major changes

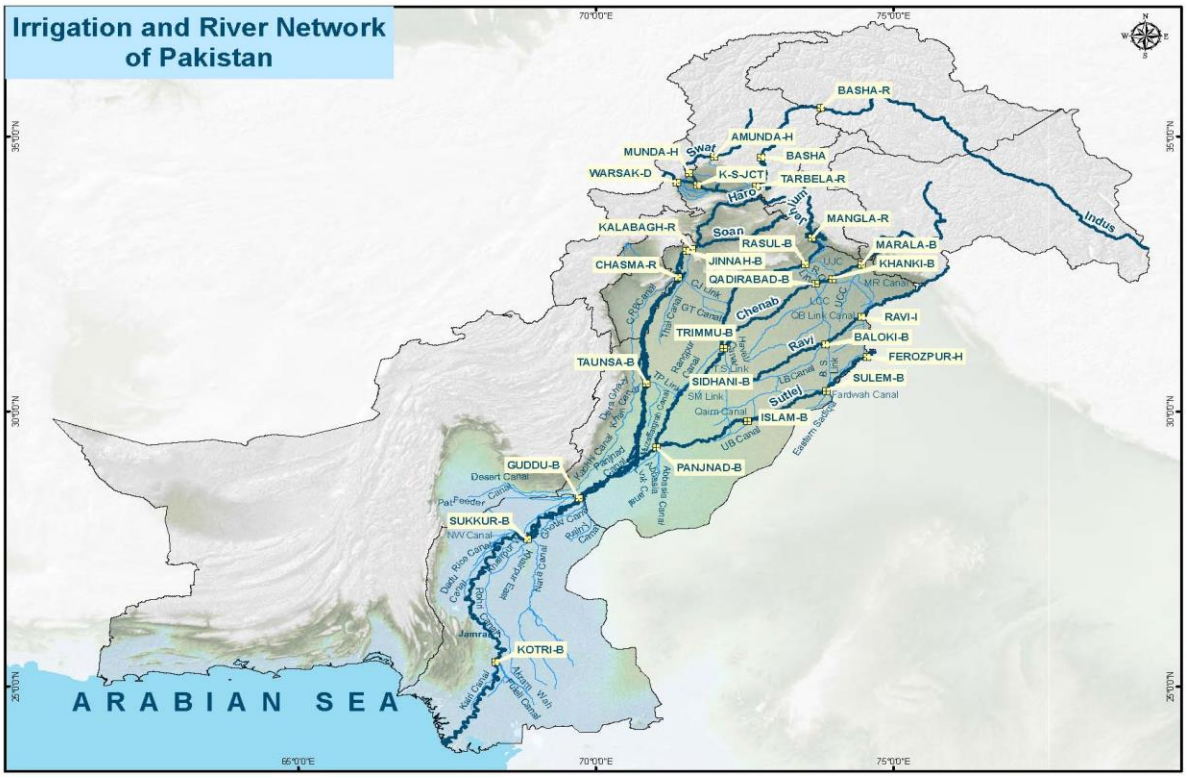
[18] Sial, *Review of Existing Environmental Laws and Regulations in Pakistan,* WWF, 2018, p.9
[19] Pakistan Ministry of Planning, Development & Reform, *Vision 2025,* 2014, pp.62-63
[20] WWF, *Basin Assessment Scenario Intervention Tool: Overview*, www.wwfpak.org/wwf-projects/BASIT.php [accessed 31st May 2019]
[21] Tindale, M., and Sagris, T., *Managing Water Use in Scarce Environments: A Catalogue of Case Studies,* 2030 Water Resources Group 2013, p.43
[22] Ibid. pp.58-59

are still awaiting implementation. The scarce water resources at present cannot further withstand the heavy load of pollution that is being released, and so it must remain a priority to tackle these issues.

Agriculture sector usage:

Agriculture makes up one of the largest sectors of the economy with about an 18 percent contribution to the GDP and employs 38 percent of the national labour force[23]. Its long-term sustainability is of paramount importance. Pakistan has the largest contiguous irrigation system in the world and fourth largest irrigated area in the world. As the principal consumer of freshwater in the country, the agricultural sector's thirst will intensify with the onset of rising temperatures.

Map 1: Irrigation and River Network of Pakistan



[Source: Indus River System Authority (IRSA)[24]]

There are several facets to the use of water and wastage of water in this sector. A government research agenda states that more than 60 percent of irrigation water is lost during conveyance and application to crop fields[25]. This is mostly because the canals and watercourses are improperly lined, causing leakage and seepage into the ground. This in turn causes waterlogging and affects nearby cropland. Upgrading these canals remains a priority across all provinces to prevent evapotranspiration and the

[23] Pakistan Bureau of Statistics, *Labour Force Statistics 2017-18 – Table 17*
[24] http://pakirsa.gov.pk/images/IrrigationNetwork_Pakistan.jpg
[25] Pakistan Council of Research in Water Resources, *National Research Agenda on Water 2016-2025*, p.4

further degradation of fertile soil. Projects of this nature are currently underway but require more extensive work.

Wasteful irrigation methods:

During application, Pakistani farmers still largely utilise the highly inefficient system of flood irrigation to water their croplands. Although widely practiced, this method is detrimental to producing better crop yield. In fact, many studies have shown that you can produce 'more crop per drop'[26] by using more water economical methods such as drip or sprinkler irrigation and by creating bed and furrows, trench plantation, and levelling land appropriately for crops[27]. Despite tempting government subsidies in the drip irrigation system, uptake has been low, mostly because the upfront costs are too high for those without solid financial backing. With the 80 percent subsidy to install solar plants in farms, many landowners found it easier to reduce their high diesel costs for running the pumps. However, some find it challenging to implement drip irrigation in row farming with crops such as maize, wheat, and rice. Provincial government agencies need to impress upon the need for awareness at the grassroots amongst farmhands who struggle to come to terms with alien methods of irrigation that require almost 50 percent less water per acre[28].

Scheduling irrigation has also proved effective in many regions across the world. In India, sugarcane farmers were advised through text messages when to begin irrigating and for how long. This is a great method in a country where the vast majority of the rural population has access to phones but lacks the basic knowledge required in scientifically determining the most efficient way to irrigate their crops. As such, it could be implemented in Pakistan as well[29]. Another water saving method in which to irrigate crops that has seen success in Israel, is to use effluent water. This water that would usually be left to drain into the sea is instead reclaimed and stored in an underground aquifer – a step that further reduces losses through evaporation. Presently, over 40 percent of Israel's agricultural water is supplied by effluent water[30].

Furthermore, water requirements for each crop should be established and every stakeholder (landlord, farmer, sharecropper etc.) should be made aware of this benchmark in order to swiftly implement it at the cropping level. Some agricultural produce such as cotton and rice are high in water demand. With increasing soil salinity, particularly in the lower Indus basin, and the greater likelihood of extreme weather events, farmers should be encouraged to plant more drought resistant, flood resistant, and salt resistant crops in their respective areas.

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[26] PCRWR, PARC, ICARDA, *Solar-Powered Pumping Systems for High Efficiency Irrigation: Design Manual for Practitioners*, 2015, p.iv

[27] Kamal, S., Amir, P., Mohtadullah, K., *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities*, WWF, 2012, p.85

[28] Ebrahim, Z. *Farmer turns Pakistan's sand dunes green,* The Third Pole, 31st May 2019, www.thethirdpole.net/en/2019/05/31/farmer-turns-pakistans-sand-dunes-green/ [accessed 19th June 2019]

[29] Tindale, M., and Sagris, T., *Managing Water Use in Scarce Environments: A Catalogue of Case Studies,* 2030 Water Resources Group 2013, p.49

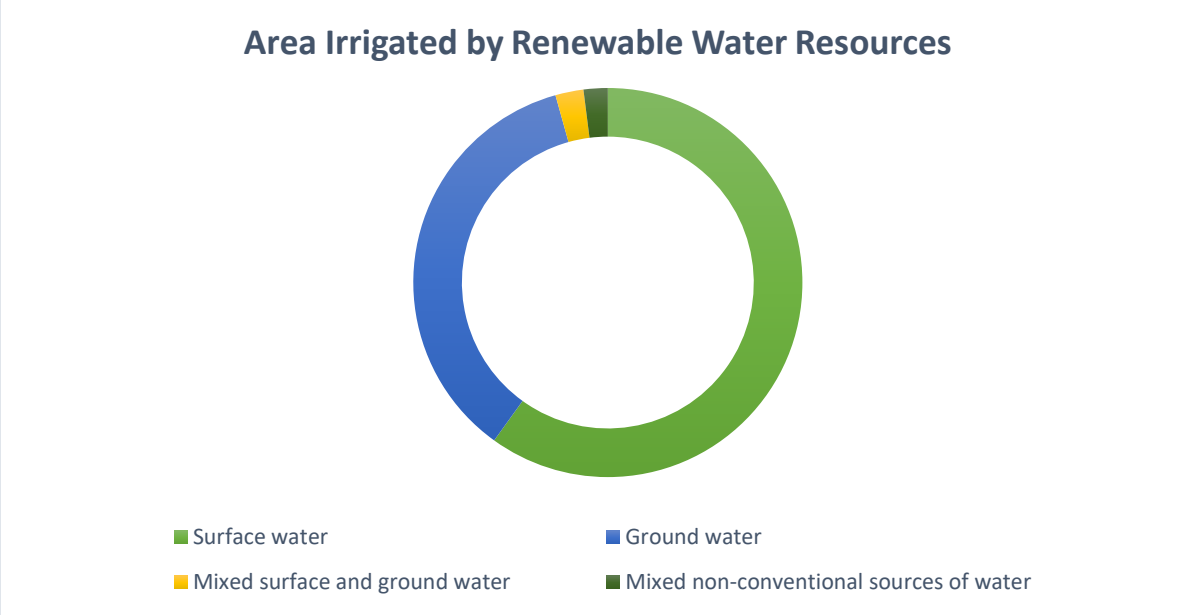
[30] Water Scarcity Solutions, *NEW - Effluent treatment and aquifer storage for agricultural use*, 19th February 2016, www.waterscarcitysolutions.org/new-effluent-treatment-and-aquifer-storage-for-agricultural-use/, [accessed 2nd August 2019]

Kamal et al. believe that an important shift from 'water supply' to 'water demand' must be made and requests for more water must be critically analysed. "Why should this demand be considered when agriculture already absorbs 97 percent of the total mobilized surface water, and almost all the groundwater, for supporting one of the lowest agricultural productivities in the world per unit of water and land?" An important observation is regarding the drought of 1999-2000, where despite the drastically low water availability, a bumper crop of wheat was harvested.[31] This proves that it is possible to produce a higher crop yield using less water.

Rapid groundwater depletion:

As a result of unpredictable and varying water supply from the river basin, large swaths of cropland are irrigated through pumping groundwater. The year-round availability of this freshwater resource allows for easy access during even the *Rabi* or dry months when river flows are weak. Groundwater is especially useful for farmers at the tail end of the Indus basin irrigation system who often don't feel they receive enough water required to grow their crops. However, reliance on this formerly abundant resource has led to an unhealthy decline in the water table. At present, far too much water is being pumped out of underground aquifers far too quickly; with not enough time given for these aquifers to replenish naturally.

Graph 2: Area Irrigated by Renewable Water Resources



[Source: FAO 2008]

[31] Kamal, S. et al, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities,* WWF, 2012, p.26

For example, in Balochistan, irrigation to apple trees exceeds 100 percent. This is not only an unnecessary waste of water but has caused many orchards to fall into ruin as a result of lowering groundwater levels[32]. More energy is also needed to draw out the same amount of water as a result of this. Subsidies for farmers in electricity mean that overuse of pumps to extract water take a toll on public electricity boards and not on the farmers themselves. This cycle of overuse and extraction is not sustainable in the long term[33]. It has been suggested that the canal system should be upgraded and repaired where critical while allowing water to seep out from canals in areas where groundwater needs to be recharged[34]. The irrigation department must take control of regulating and monitoring groundwater tube-well installations. They must also determine the volume of water in an aquifer over time and the amount being pumped out, since, at present, there is insufficient data collection on this front.

Citrus orchards in Florida, USA, which previously relied heavily on groundwater for irrigation, are now irrigated through reclaimed and treated wastewater. Early on, citrus farmers were incentivised through offers of free water for 20 years. This project led to a successful recharge of groundwater in the Floridian Aquifer System. The capital and operating costs were covered by the costs for treating and selling treated wastewater. Rapid infiltration basins also aided in increasing groundwater recharge quickly and efficiently. Importantly, the reclaimed water in Florida has been a blessing for citrus farmers in maintaining their orchards – even during times of drought – tree growth as well as fruit weight has seen an increase, leading to higher overall fruit crop[35].

Yemen also provides a good case study for groundwater conservation. Through several targeted measures, there was an increase in productivity with reduced water withdrawals. This was achieved by improvements to spate irrigation methods (using seasonal floodwater to irrigate land) and by constructing ponds and cisterns to store rainwater. This led to less reliance on groundwater for farmers' irrigation needs. Small dams were also constructed to facilitate groundwater recharge and groundwater levels and abstraction was measured; allowing for farmers to realise the impact their usage was having on aquifer depletion[36].

The Pakistan Supreme court has ruled that water companies operating in Pakistan must pay Rs. 1 per every litre of groundwater they extract. Although a step in the right direction, the collections from this have been directed to the Diamer-Bhasha dam fund – problems with which have been addressed in the water storage section. Nonetheless, it would have been far more appropriate to direct these funds to improving efficiency in current water institutions and infrastructure. Furthermore, the judgement by the apex court has not been enforced as it is economically impractical and therefore unfeasible.

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[32] Kahlown, M. A., and Majeed, A., *Water-Resources Situation in Pakistan: Challenges and Future Strategies,* Science Vision, vol.7, 2002, p.40
[33] ADB, *Asian Water Development Outlook,* 2007, p.4
[34] Kamal, S., et al, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities,* WWF, 2012, p.27
[35] Tindale, M., and Sagris, T., *Managing Water Use in Scarce Environments: A Catalogue of Case Studies,* 2030 Water Resources Group 2013, pp.40-41
[36] Ibid. pp.34-35

Pakistan also suffers from the intrusion of brackish water into freshwater aquifers. New technologies have been developed and used in Australia that allow for the extraction of brackish water from underground aquifers, which can then be used for a variety of municipal purposes. This is being considered for use in both the agricultural and industrial sectors[37] and the technology should be explored by Pakistan.

The need for appropriate water pricing and taxation:

The most crucial issue that lies at the heart of the waste of water is the pricing, subsidies, and lack of cost collection in the agriculture sector. This has been highlighted in numerous reports by the IMF, WWF, and government agencies. The current *abiana* water pricing covers only 24 percent of the annual operating and maintenance costs. Collection of this minimal fee is at 60 percent[38]. It raises an important point on the value – or lack of perceived value – of water in agriculture. In previous instances, even though farmers were incentivised by the government to practice more judicious use of water for irrigation, the expected results were not delivered. It is therefore understood that without appropriate reform in water pricing and subsidies, there will be little to no change in the way that water is used in this sector[39].

Table 2: *Abiana* Assessment and Recovery

	Assessed Amount (million rupees)			
Province	**FY01**	**FY10**	**% Change**	**Recovery: Assessment Ratio**
Punjab	2260	1662	-26.5	63.4
Sindh	453	261	-42.4	89.3
KPK	197	229	16.2	63.6
Balochistan	45	200	344.4	15.1

[Source: SBP[40]]

However, it has also been noted that water pricing without water on demand is an 'unrealistic concept'. For water to be priced appropriately, it has to be available for those who pay for it on demand whenever required[41]. At the current rate of unpredictable seasonal flows, it would be impractical to expect water available on request to farmers, especially at the tail end of the irrigation system and during the *rabi* season. This is an issue that has to be resolved through upgrading and restoring storage

[37] Water Scarcity Solutions, *NEW – Creation of 'New Water' from saline aquifer,* 22nd June 2016, www.waterscarcitysolutions.org/new-creation-of-new-water-from-saline-aquifer/ [accessed 2nd August 2019]
[38] IMF, *Issues in Managing Water Challenges and Policy Instruments: Regional Perspectives and Case Studies,* 2015, p.13
[39] Kamal, S. et al, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities,* WWF, 2012, p.71
[40] SBP, *State Bank of Pakistan's Annual Report 2016-17,* 2017, p.100
[41] Kamal, S. et al, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities,* WWF, 2012, p.71

facilities that can guarantee a certain volume of water to be released throughout the year. Nonetheless, it should be pointed out that electricity across Pakistan is priced at a reasonably high rate despite its lack of availability and constant load-shedding. Considering a water scarce future and until adequate solutions are implemented, the *abiana* system must be rationalised in order to cover the basic costs of developing, abstracting, storing, and distributing water. This the IMF too believes is critical[42] and has been recognised in Vision 2025 as one of the many necessary steps to be taken.

The problem then lies with the political system in place that is, by all accounts, resistant to any changes in the status quo. In this country, owning land permits access to irrigation water. In Southern Punjab and Upper Sindh there are large landholdings where water has been appropriated by landlords. Those who grow the crops and deal with irrigation water first-hand do not own the land and therefore do not feel invested in the system[43]. It, therefore, means they are less incentivised to make changes in the way they grow crops because of the relatively little impact it has on them.

Farmers in South Africa face a similar situation where many are allocated water based on their landholdings. However, with effective metering, they only need to pay for the water they extract or use. A water bank, managed by Water Users Association, allows farmers to sell off their excess allocation of water and conversely allows those who need more water to purchase it. However, those wishing to buy water will have to pay a premium of 30 percent (charged by the Association)[44] which encourages judicious use of existing water allocations. Australia also has an upgraded water trading system – operational for the past 50 years – which allows for 'real-time' trading of water entitlements[45]. A water 'bank' that allows for trading between farmers should be considered in Pakistan – particularly between provinces, where farmers on the tail end of the system don't seem to receive an adequate enough share of water.

In a country like Pakistan, it is necessary to bear in mind those most disadvantaged by changes in pricing and tariffs. However, according to a WWF report, landholdings are largely organised by sharecropping arrangements, meaning that the advantages of low prices and reduced tariffs don't directly benefit the tenants themselves, but rather benefit the wealthy landlords who pay subsidised prices. The report suggests reforming the existing tenancy laws to overcome this problem[46]. This is a valuable long-term solution, but for the short term and more pressing water concerns, water price reforms must be implemented in a way that don't negatively impact those unable to afford them.

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[42] IMF, *Issues in Managing Water Challenges and Policy Instruments: Regional Perspectives and Case Studies,* 2015, p.13

[43] Kamal, S. et al, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities,* WWF, 2012, pp.26-27

[44] Tindale, M., and Sagris, T., *Managing Water Use in Scarce Environments: A Catalogue of Case Studies,* 2030 Water Resources Group 2013, pp.28-29

[45] Ibid. p.45

[46] Kamal, S. et al, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities,* WWF, 2012, pp.26-27

It is likely that any government will struggle to pass reforms in the *abiana* system because of powerful and politically influential landowners. A cap on water extraction by area, enforced with fines, is a quicker alternative that should be introduced. A similar cap set on water supply relative to demand has proven effective in many countries as varied as Australia and China[47]. Paired with a telemetry system – installation of which is currently underway across waterways in Pakistan – this would be a valuable tool through which to monitor and prevent the over-use of water.

As noted by an IMF report, the agriculture sector remains largely untaxed – contributing only about 0.1 percent to total tax revenues despite having a large share in the country's GDP[48]. An increase in taxes is recommended whilst removing loopholes that prevent those able to pay tax from not doing so.[49]

Unfortunately, the pricing structure for crops is also not very nuanced. All crops are priced uniformly although those that use far more water than others should reflect this in their pricing[50]. The idea of 'virtual water' has gained traction in most other countries where governments measure the volume of water that has gone into producing a certain crop. This practice has not yet been implemented in Pakistan. By utilising the concept of virtual water, there will likely be a change in the way that water is used and a change in the perceptions of those who produce the crops as well as those who consume them.

None of this, however, compares to the amount of water needed to produce meat from livestock. It is estimated that one kilogram of meat requires 20,000 litres of water compared to 1,200 litres to produce the same amount of grain. The global demand for meat is also set to rise to 50 percent by 2050[51]. All these factors will have to be assessed by respective provincial governments while involving stakeholders and creating awareness among the general public about the state of water affairs now, and those forecast for the future.

Barriers to effective reform:

To pass necessary reforms and to effectively enforce them, a strong political will is needed coupled with accountable institutions with clearly defined roles. At present, Pakistan is lacking both. The State Bank's annual report for financial years 2016-17 describes how, as a result of incomplete irrigation department reform, two irrigation management bodies exist simultaneously, with overlapping responsibilities and unclear demarcation of areas of management.[52] A World Bank report reinforces

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[47] Iceland, C., *Water Stress is Helping Drive Conflict and Migration: How Should the Global Community Respond?*, WRI, www.wri.org/news/water-stress-helping-drive-conflict-and-migration [accessed 31st May 2019]

[48] IMF, *Issues in Managing Water Challenges and Policy Instruments: Regional Perspectives and Case Studies,* 2015, p.14

[49] Kamal, S. et al, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities,* WWF, 2012, p.94

[50] IMF, *Issues in Managing Water Challenges and Policy Instruments: Regional Perspectives and Case Studies,* 2015, p.13

[51] Waughray, D., *Why Worry About Water? A Quick Global Overview,* WRG, 10th November 2010, www.2030wrg.org/why-worry-about-water-a-quick-global-overview/ [accessed 31st May 2019]

[52] SBP, *State Bank of Pakistan's Annual Report 2016-17,* 2017, p.101

this view by stating that the biggest challenge to water security is from governance-related issues. The report points out deficiencies in legal frameworks and incomplete policy formulations on water risks. Moreover, it claims "behind these multiple challenges in the formal governance arrangements are deeply embedded vested interests in the status quo that have proved resistant to reform."[53] Provincial irrigation systems must gradually develop into 'water resource management agencies' that enable modernisation of present irrigation systems and practices. Young et al. believe these reforms are most crucial for Sindh considering the complexity of water problems in the province[54].

A case study of the Hai Basin in China demonstrates how important it is to increase stakeholder participation and carry out necessary institutional reforms. The changes helped substantially reduce water usage in agriculture whilst also increasing crop productivity and therefore increasing mean farmer income. Institutional reforms allowed for cross-sectoral cooperation at the national, provincial, and county levels as well as efficient cooperation between administrative management. Participation from the public further ensured changes were implemented effectively at the grassroots. The problems of collecting water charges – as is faced by Pakistani water management institutions – was rectified through metering, and collected money was used for the improvement of water infrastructure in the area[55]. This meant that that those paying for water saw the direct and tangible benefits of their tax.

Water User Associations:

Yemen, China, and South Africa are but a few examples of countries where Water User Associations (WUAs) have benefitted both the farmer and the government in managing their water resources. In Yemen, the WUA assisted in educating local farmers about the dangers of excessive groundwater use and acted as a medium for communication about water issues[56]. In South Africa (and in Mexico[57]), the WUA are liable to be held accountable as they are responsible for fully covering the costs of access to water. This naturally has forced the WUA and farmers to be more efficient and sustainable in their water use. As a result, 60 percent of farmers have abandoned the traditional flood irrigation methods – widely employed in Pakistan. Those that do still practice this method do so out of necessity as salinity in cropland can often only be counteracted by flooding with freshwater.[58]

One way to foster political will in a democracy is to have the people demand it. Therefore, intensive lobbying on behalf of NGO's and other associations is needed as well as an effective campaign that raises awareness about the water crisis in all its aspects; usage, storage, and conflict.

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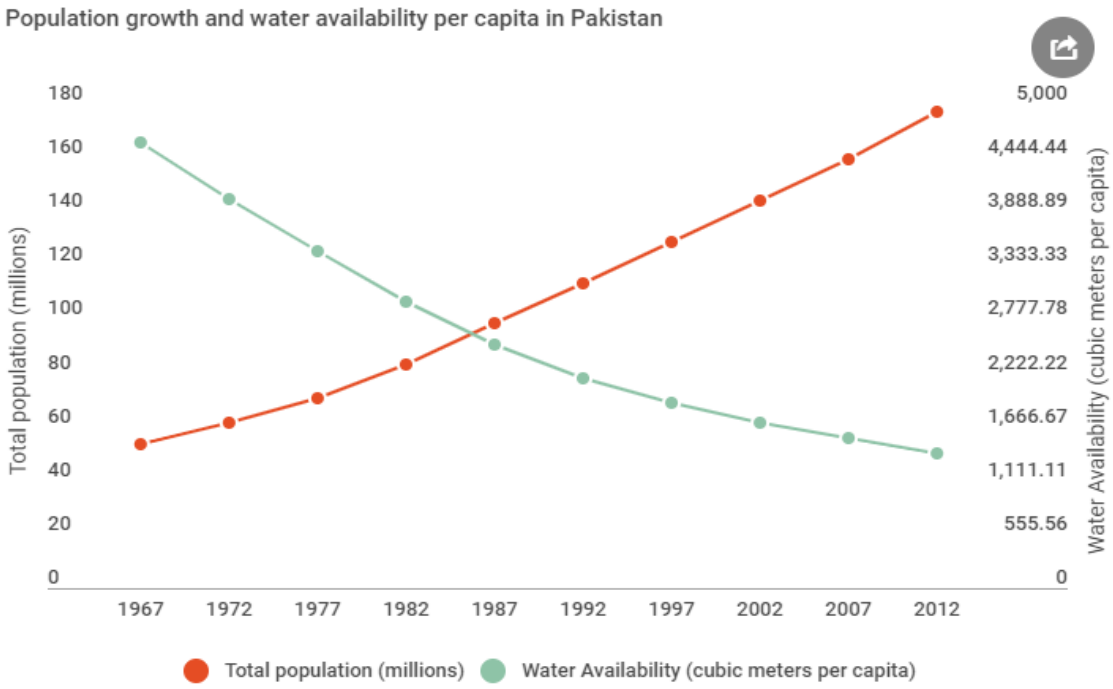
[53] Young, W. Anwar, A. et al., *Pakistan: Getting More from Water,* World Bank, 2019, p.xviii
[54] Ibid. p.133
[55] Tindale, M., and Sagris, T., *Managing Water Use in Scarce Environments: A Catalogue of Case Studies,* 2030 Water Resources Group 2013, pp.24-26
[56] Ibid. p.35
[57] Water Scarcity Solutions,, *New – Integrated Irrigation Modernization Project (46-B),* 17th August 2017, www.waterscarcitysolutions.org/new-integrated-irrigation-modernization-project-46-b/, [accessed 2nd August 2019]
[58] Tindale, M., and Sagris, T., *Managing Water Use in Scarce Environments: A Catalogue of Case Studies,* 2030 Water Resources Group 2013, p.39

There are many changes that need to be seen across the board. Water usage doesn't just cover the amount of water that is being used by a particular division, other factors such as water disposal post-use is of paramount importance too. It is clear, however, that strict monitoring, regulation, and enforcement needs to be exercised by respective provincial governments in all sectors. Projects being funded by institutions such as the ADB in Balochistan are good examples of effective water management, however, effective governance and accountability is the only way forward for the future.

Water Storage

Adequate storage of water has been impressed upon as a matter of great national urgency. Dams in particular have seen a great deal of interest in Pakistan, but they all have a limited lifespan. The two largest ones, Tarbela and Mangla, are both approaching the end of theirs. To date, there are reportedly 164 water storage facilities[59], but these are woefully inadequate to deal with future challenges in water scarcity. Recently, there has been a surge of awareness for the necessity of constructing more dams as a result of the former Chief Justice of Pakistan (CJP) and Prime Minister's dam fund. Scepticism and dissent have plagued the project from professionals in the field who believe that the structure is not feasible; financially or otherwise. However, it remains essential to build more infrastructure in order to manage rapidly depleting water resources. Methods to address concerns have to be brainstormed and efficiently implemented in time to avoid catastrophe.

Graph 3: Population growth and water availability per capita in Pakistan



[Source: FAO]

Dams can also be effectively used to recharge groundwater levels as demonstrated by the Omdel Dam in Namibia. The large structure was built upstream from the aquifer to allow floodwater to seep into the ground through enhanced filtration. This method reduced the amount of water lost through

[59] International Commission on Large Dams, *Number of Dams by Country Members*, www.icold-cigb.org/article/GB/world_register/general_synthesis/number-of-dams-by-country-members [accessed 14th June 2019]

evaporation, reduced annual discharge into the Atlantic Ocean by 35 percent and increased annual average recharge to the aquifer by 100 percent[60].

Presently, the storage capacity of reservoirs and dams is limited to 30-35 days. This is a staggeringly low number compared to India (220 days)[61] and Pakistan falls well short of the recommended 1000-day average of countries with similar climates[62]. The 30-day figure is targeted to increase to 90 days by 2050 according to Vision 2025[63], but so far, there has not been any progress in meeting this goal. As a result of a population boom and climate change, current water reserves will be insufficient to meet the needs of the country in 30 years.

The Diamer-Bhasha dam has seen increased interest as a result of the former CJP's campaign to raise funds for the construction of the large-scale hydropower and storage facility. However, successive reports and articles by professionals has cast doubt on the feasibility of the project. Funding has been rejected by the IMF, ADB, World Bank, and China amid serious seismic and geo-political concerns[64].

To shed some light on the background of this project, the Diamer-Bhasha is expected to be among the largest gravity dams in the world upon completion. Situated on the Indus river in the region of Gilgit-Baltistan, it would increase total storage capacity by 10 million acre-feet (MAF)[65]. It would further reduce sedimentation load into the Tarbela dam site, increasing its lifespan[66]. This is one of the justifications provided for securing funding in the medium term for the Diamer-Bhasha in a recent World Bank report[67]. The government's Water Sector Strategy recognises there is a great need to develop and upgrade water-related infrastructure as a result of deterioration. However, as explored below, there are difficulties in reaching a consensus between the provinces on this issue[68].

Conflict over the impact of dams:

At the heart of the conflict are not the dams themselves but rather the issues surrounding their construction, which intrinsically links this to water and conflict since most protests against further water development upriver stems from communities downriver (primarily Sindh).

The Pakistan Fisherfolk Forum (PFF) argue that the construction of further water storage reservoirs will leave agricultural communities in Sindh at the mercy of saltwater intrusion and place cities like

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[60] Tindale, M., and Sagris, T., *Managing Water Use in Scarce Environments: A Catalogue of Case Studies,* 2030 Water Resources Group 2013, pp.72-73

[61] International Monetary Fund (IMF), *Issues in Managing Water Challenges and Policy Instruments: Regional Perspectives and Case Studies,* 2015, p.13

[62] Asian Development Bank (ADB), *Asian Development Outlook 2013: Asia's Energy Challenge,* 2013, p.208

[63] Pakistan Ministry of Planning, Development & Reform, *Vision 2025*, 2014, p.62

[64] Ghumman, M., *Diamer-Bhasha Dam: China refuses to finance project*, Business Recorder (30th December 2017), https://fp.brecorder.com/2017/12/20171230331333/ [accessed 14th June 2019]

[65] Pakistan Ministry of Water Resources, *National Water Policy* (2018), p.33

[66] Kamal, S. et al, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities*, WWF (2012), p.29

[67] Young, W. Anwar, A. et al., *Pakistan: Getting More from Water,* World Bank (2019), p.135

[68] Pakistan Ministry of Water Resources, *Pakistan Water Sector Strategy – Executive Summary Vol. 2*, (2002), pp.27-28

Karachi at risk. Saeed Baloch, Secretary General of the PFF believes that dams upriver have been devastating for the Indus Delta. The lessened flow of water has had a negative impact on natural mangroves that serve as a vital part of the communities' livelihood and are home to a multitude of essential species of flora and fauna[69]. The Tarbela and Mangla dams both served their purpose in generating energy and channelling water for irrigation, but they also gradually led to the desertification of millions of acres of land in the Indus Delta region of Sindh[70]. Those supporting the Diamer-Bhasha argue this case is different, since water will not be diverted for irrigation and therefore will not have a negative impact downriver[71]. However, the Special Assistant to the Sindh Chief Minister has emphatically stated that, "We are taking up this matter with the federal government and will not allow the construction of any dams that further reduces our share of water"[72]. This stance is fostered in part because of the lack of trust between provinces; an issue discussed further in the water and conflict section.

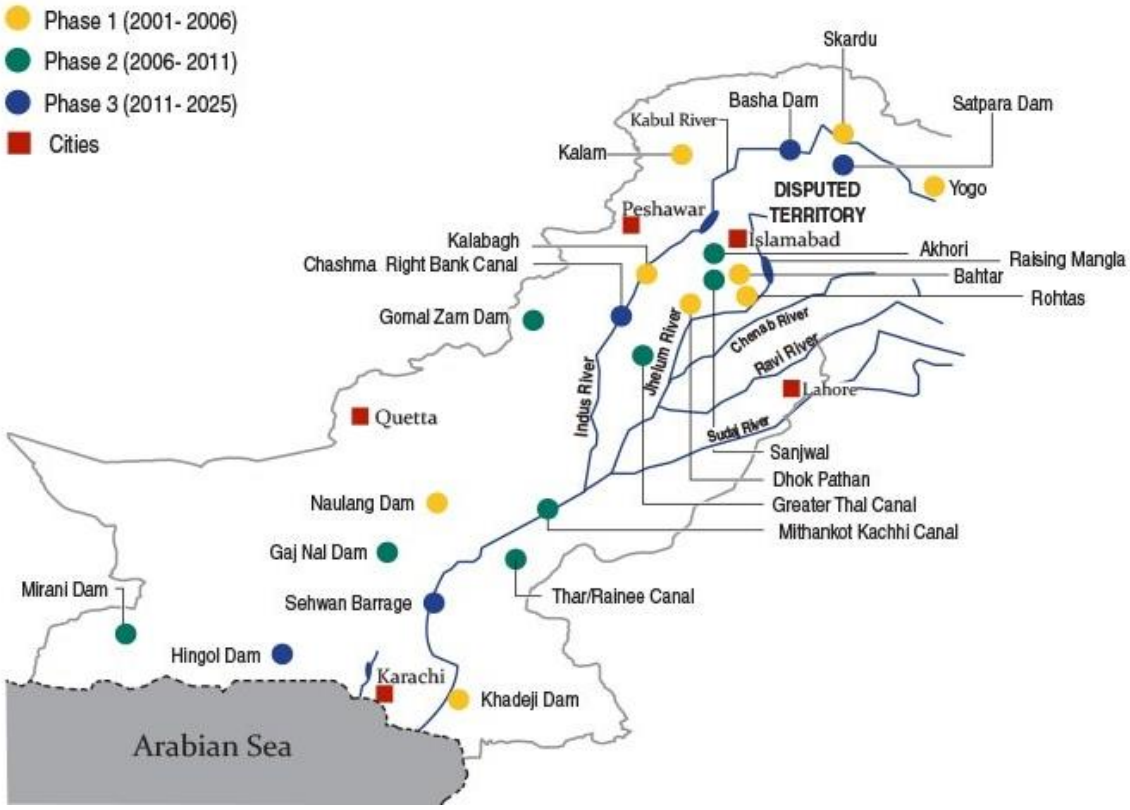
Sustainable environmental flows refer to the need for a certain amount of water to be released into the Indus basin to guarantee the functions of a healthy ecosystem. Therefore, valid concerns must be considered when building any structure that could potentially affect these flows. A World Bank report further states that new reservoirs will have a minimal effect on water availability and be less reliable since a lessened flow of water downstream during the *Rabi* season will likely exacerbate environmental degradation. Additional storage reservoirs will have to carefully assess the impacts of increased water withdrawals in order to justify their construction. However, the report also acknowledges that these new structures would mitigate seasonal flow variations and the threat of floods[73]. Considering the severe flooding that has hit several regions in Pakistan recently, causing severe environmental and human damage, these reservoirs must be constructed to safeguard the livelihoods and security of people who suffer the most during such natural disasters.

The environmental impacts of dams should be a priority in all reports produced. In the Tarbela and Mangla cases, hundreds of villages were submerged, and thousands uprooted. Compensation and rehabilitation, though promised, is allegedly still pending[74]. Assurances made by government or local bodies must be followed through with action to ensure trust and amity between provinces.
The Water and Power Development Authority (WAPDA) predicts that Diamer-Bhasha will displace around 4,200 families and potentially submerge portions of the Karakoram Highway. Daanish Mustafa, a researcher in Politics and Environment at King's College, London, finds it baffling that WAPDA would wish to continue construction of the dam considering the risks to irrigation

[69] Khan S., *Pakistan's dam threaten mangroves and livelihoods,* DW (12th December 2018), www.dw.com/en/pakistans-dams-threaten-mangroves-and-livelihoods/a-46696480 [accessed 14th June 2019]
[70]Khan, M. I., *Pakistan's disappearing delta areas,* BBC, 3rd August 2007, http://news.bbc.co.uk/2/hi/south_asia/6278502.stm, [accessed 14th June 2019]
[71]Hussain A., *The mega-dam being crowdfunded by Pakistan's top judge*, BBC (30th October 2018), www.bbc.com/news/world-asia-45968574 [accessed 14th June 2019]
[72] Khan S., *Pakistan's dam threaten mangroves and livelihoods,* DW, 12th December 2018, www.dw.com/en/pakistans-dams-threaten-mangroves-and-livelihoods/a-46696480 [accessed 14th June 2019]
[73] Young, W., Anwar, A. et al., *Pakistan: Getting More from Water,* World Bank, 2019, p.xix
[74]Hussain A., *The mega-dam being crowdfunded by Pakistan's top judge*, BBC, 30th October 2018, www.bbc.com/news/world-asia-45968574 [accessed 14th June 2019]

infrastructure[75]. It leads to the conclusion that it is necessary, again, to fully assess long-term effects on the environment when considering this project. Any study should include a balanced assessment on the "trade-offs between the benefits provided and their detrimental effects on biodiversity, ecosystem services, and riparian livelihoods"[76].

Map 2: Planned water storage projects in Pakistan



Additionally, India has also protested the construction of this particular storage facility based on its contested location in Gilgit-Baltistan. In the government's efforts to secure funding for Diamer-Bhasha, the IMF, ADB, World Bank, and China were approached. Among other concerns, they all flagged the issue of the dam's location in disputed territory. The Secretary for Water Resources confirmed that India had refused to share a No Objection Certificate (NOC). Therefore, it would be difficult to include the power project as part of the China Pakistan Economic Corridor (CPEC)[77].

[75] Janjua, H., *Crowdfunding for dams – why Pakistani PM Khan's drive is not feasible,* DW, 26th September 2018, www.dw.com/en/crowdfunding-for-dams-why-pakistani-pm-khans-drive-is-not-feasible/a-45644405 [accessed 14th June 2019]

[76] Kamal, S., et al, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities,* WWF, 2012, p.33

[77] Ghumman, M., *Diamer-Bhasha Dam: China refuses to finance project*, Business Recorder, 30th December 2017, https://fp.brecorder.com/2017/12/20171230331333/ [accessed 14th June 2019]

Afzal Ali Shigri, a proponent of the dam, believes that the only way forward is through determining the status of Gilgit-Baltistan through legal and constitutional means. "A vague and uncertain stance imperils the confidence of prospective donors/investors". He recommends a conditional merger - subject to the results of a plebiscite under the UN – in order to proceed with crucial projects such as this[78]. However, it is unlikely that such a merger will be carried out soon, as by Shigri's own admission, the Diamer-Bhasha is a case of "lack of political will"[79] on behalf of successive governments. At present, Pakistan does not have the luxury of time to resolve this issue and later begin construction on the dam. It is more important to realise alternative solutions that are easily and quickly implementable.

Problems with financing large dams:

Another factor to consider is the financing required, particularly for larger dams. In the recent government budget announcement for 2019, Rs.20 billion was allocated to the Diamer-Bhasha for land acquisition. Yet this amount is unlikely to put much of a dent in the total cost required for such a vast project. A study led by researchers from Oxford University analysed the costs of 'hydropower megaprojects development' and came to the following conclusion: "The outside view suggests that in most countries large hydropower dams will be too costly in absolute terms and take too long to build to deliver a positive risk-adjusted return". The only caveat is if suitable risk management measures are provided. The time it takes to build large dams is also too long for them to be used to solve impending energy crises[80] – or water crises too. The study gives the example of the construction of the Tarbela Dam post-partition. Due to delays and inflation, the actual cost of the facility was nearly 4 times its initial budget. The researchers believe that with large-scale storage and hydropower projects, it is almost impossible to adequately prepare for financial challenges, even when anticipated[81].

The World Commission on dams stated that, on average, dam projects suffer approximately a 98 percent cost increase. Even in the development of the Neelum-Jhelum run of the river project, the cost overrun was 500 percent[82]. Researchers have further assessed the future financial feasibility of Diamer-Bhasha which they state, using methods to forecast cost and time overrun, will end up costing approximately $35 billion, or 11 percent of Pakistan's GDP in 2018. Crucially, they warn, "a future sovereign default in Pakistan owing to this one mega-dam is not a remote possibility"[83].

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[78]Shigri, A., *The Diamer-Bhasha challenge,* DAWN, 15th October 2018, www.dawn.com/news/1439157, [accessed 14th June 2019]

[79]Ibid.

[80] Ansar, A., et al., *Should we build more large dams? The actual costs of hydropower megaproject development,* Energy Policy, vol.69, June 2014, p.43-44

[81] Ibid. p.53

[82] Mustafa, D., *Folly thy name is Diamer-Bhasha,* Daily Times, 10th September 2018, https://dailytimes.com.pk/295537/folly-thy-name-is-diamer-bhasha/ [accessed 14th June 2019]

[83] Ansar, A., et al., *Should we build more large dams? The actual costs of hydropower megaproject development,* Energy Policy, vol.69, June 2014, p.54

Another World Bank report that supports this view argues that large storage reservoirs should not be constructed. It argues that Pakistan holds an unfounded belief that there is inadequate water storage leading to deficiencies in water management. In reality, the low productivity of water does not economically justify the construction of expensive reservoirs. [84] The only case in which large dams could be economically viable is if they develop hydropower facilities as well[85].

Safety hazards - a cause for concern:

Focusing on the Diamer-Bhasha case, even if there is a resolution to the problems highlighted above regarding conflicts over construction and financial constraints, the safety concerns identified below will be much harder to overcome.

In a recent special report for DAWN, two experts - on structural and seismic engineering related to dams - analysed the safety hazards at the Diamer-Bhasha site. Specifically, they listed the seismic risks that are present. The location of this dam is directly on the zone where two continental tectonic plates meet and collide[86]. According to Bashir Malik – a consultant engineer for the World Bank and United Nations – the weight of water behind large dams is often a trigger for massive earthquakes[87]. Malik also notes that the Bhasha dam report initially released in 1984 did not address the risk of reservoir induced seismicity – a grave error considering the selected location is prone to massive avalanches, landslides, rock/snow dams and lake bursts. The authors of the report believe that further, in-depth investigations are needed into the seismicity of the region and the effects this will have on the construction of the facility – particularly since any natural disaster will have a devastating impact on lives downstream[88]. This issue has also been brought forward by various potential donors as a basis for their rejection for funding the project[89].

Alternative solutions:

While there is a consensus in all sectors on the need for appropriate water storage, disagreements arise as a result of concerns surrounding large dams. Opinion is divided on the utility of constructing these costly behemoths or whether to look at suitable alternatives. Although developing countries are most in need of these hydropower and storage facilities to bolster their current and future energy and water requirements, they are cautioned to "stay away from bites bigger than they can chew"[90]. In the long term, large sites such as Kalabagh can be considered for effective power generation and water storage,

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[84] Young, W. Anwar, A. et al., *Pakistan: Getting More from Water,* World Bank, 2019, p.134
[85] Ibid, p.xix
[86] Hussain S. M. and Wieland, M., *Special Report: How safe will Diamer-Bhasha dam be?,* DAWN, 8th April 2019, www.dawn.com/news/1474554, [accessed 14th June 2019]
[87] Mustafa, D., *Folly thy name is Diamer-Bhasha,* Daily Times, 10th September 2018, https://dailytimes.com.pk/295537/folly-thy-name-is-diamer-bhasha/ [accessed 14th June 2019]
[88] Hussain, S. M. and Wieland, M., *Special Report: How safe will Diamer-Bhasha dam be?,* DAWN, 8th April 2019, www.dawn.com/news/1474554, [accessed 14th June 2019]
[89] Ghumman, M., *Diamer-Bhasha Dam: China refuses to finance project*, Business Recorder, 30th December 2017, https://fp.brecorder.com/2017/12/20171230331333/ [accessed 14th June 2019]
[90] Ansar, A., et al., *Should we build more large dams? The actual costs of hydropower megaproject development,* Energy Policy, vol.69, June 2014, p.52

however, structures in at-risk areas such as Gilgit-Baltistan should be reassessed with a thorough understanding of the risks involved.

The National Water Policy argues that large dams should be built – with provincial consensus – but further recognises that small and medium dams can be constructed for local and regional use. Natural ponds and mini as well as subsurface dams are also useful forms of storage that should be employed nationwide[91]. Subsurface dams are particularly appealing for a country such as Pakistan where there has been a sharp increase in reliance on groundwater for agricultural, domestic, and industrial needs. These underground structures are ideal for recharging aquifers, preventing saltwater intrusion, and maintaining a healthy level of the water table. They also reduce negative environmental impacts common in above-surface dams, such as flooding on surrounding areas, and further reduce the loss of reservoir water through evaporation. Pollution by surface contaminants is also drastically reduced. The disadvantages of such an underground structure involve difficulty in choosing an appropriate site and low effective water storage[92]. However, as a low cost, quick solution with minimal environmental damage, it is a highly recommended investment, particularly in coastal areas as a barrier to seawater.

Other small above-surface dams can also be promoted as a low-cost and quick alternative to larger ones. Communities across all provinces can benefit from the construction of these with a minimal effect on the equitable share of water. For example, small dams to hold floodwater or rainwater in Sindh can be used to supply irrigation water during dry months. The Supreme court ordered the immediate construction of the Nai Gaj dam in Sindh in March 2019 that would efficiently harvest rainwater. (The court also criticised the lack of coordination between the provincial and federal governments – a situation that must be rectified)[93]. The time to conduct an appraisal and furnish a report for these storage facilities is far less in comparison to that of a large one.
However, previously constructed small dams to harvest rainwater near Jhelum have come under heavy criticism for failing to fulfil their purpose. The fault lay in improper research and clumsy designs that failed to take into account the nature of hill torrents in the area or the porous riverbeds[94]. These issues are easily overcome with the right expertise and planning.

In addition to constructing small to medium dams, improving and upgrading water storage facilities currently in place is very important. Technology and equipment to remove silt from reservoirs should also be developed in order to prevent siltation and further degradation of existing structures[95]. These can then be used to extend the lifespan of dams like Tarbela and Mangla. However, the technologies should not be considered appropriate alternatives for reservoir facilities, which should be developed side by side.

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[91] Pakistan Ministry of Water Resources, *National Water Policy*, 2018, p.13-14 & 17-18
[92] Japanese Ministry of Environment, *What is a subsurface dam?*, http://www.env.go.jp/earth/report/h16-08/eng/PDF/012.pdf [accessed 14th June 2019]
[93] Staff Report, *SC orders* [accessed 15th June 2019]
[94] Safdar, R., *The big problems created by small dams in Potohar*, Herald, 26th November 2018, https://herald.dawn.com/news/1398735, [accessed 20th June 2019]
[95] Kamal, S. et al, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities*, WWF, 2012, p.33

The construction of weirs to store stormwater and divert it for treatment has proved successful in Australia. A benefit of this treatment has reduced the sediment and silt load that flows into water ways[96]. Harvesting flood and stormwater could also lessen the degradation of the Tarbela and Mangla dams as a result of siltation.

Furthermore, wetlands, forests, and other native landscapes are also natural stores of water. Preserving these areas and artificially creating more should be a priority, particularly in small communities affected by water scarcity[97]. A WWF report notes that these water bodies can be developed on otherwise unproductive land (usually near rivers) and provide temporary floodwater storage[98].

Way forward:

Annually Pakistan is losing millions of acre-feet of water because of inadequate and lack of necessary storage facilities. The proposed water projects, however, are heavily criticised and professionals and stakeholders alike have raised valid concerns.

It is necessary to immediately construct more dams nationwide, however, the government should pursue sites in areas like Kalabagh that do not suffer from the breadth of complex problems faced by the Diamer-Bhasha. The present government with its strong ties to the KPK province has a unique advantage in being able to push for the Kalabagh dam. Regional fears must be allayed, particularly when there is a lot of mistrust between provinces. One of the main issues lies with financing, since often cost-benefit analyses have overlooked or under-estimated the potential negative impact of water development interventions on people or the environment, while overestimating other benefits[99].

Hydrology experts believe that another mega-structure is not the solution for water shortages but improving management practices certainly is[100]. In order to have effective water storage, it is crucial to have effective watershed management. Whether large dams are constructed or not, Pakistan will still face the threat of scarcity if water continues to be used at the current volume and waterways continue to be polluted. Small and medium storage structures along with regulated use of water is essential.

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[96] Tindale, M., and Sagris, T., *Managing Water Use in Scarce Environments: A Catalogue of Case Studies,* 2030 Water Resources Group (2013), p.93

[97] Iceland, C., *Water Stress is Helping Drive Conflict and Migration: How Should the Global Community Respond?,* WRI, www.wri.org/news/water-stress-helping-drive-conflict-and-migration [accessed 31st May 2019]

[98] Kamal, S. et al, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities,* WWF, 2012, p.33

[99] FAO, *FAO Water Reports - Coping with water scarcity: An action framework for agricultural and food security,* 2012, p.XV

[100] Hussain, A., *The mega-dam being crowdfunded by Pakistan's top judge,* BBC, 30th October 2018, www.bbc.com/news/world-asia-45968574 [accessed 14th June 2019]

Effective awareness campaigning:

The public should also be made aware of the looming crisis which will affect urban and rural populations. The crowdfunding campaign initiated by former Chief Justice Saqib Nisar was an effort to do just that. It impressed upon the need for building more water storage facilities in Pakistan. However, this method has many shortcomings. By encouraging citizens to contribute monetarily, a false impression was conveyed, mainly that it would be feasible to finance one of the largest dams in the world solely through donations from the public. Donating money to a cause allows the donor to disengage from the problem at hand after doing their part, without introducing any changes to their lifestyle. It further alienates those who are unable to contribute through monetary means. The former CJP later issued a notification to TV channels forbidding any criticism of the dam funding drive and warned critics that they could be charged with high treason for opposing the water project[101]. This is definitely not an effective way to campaign and serves only to stifle valid debate that is essential to any democracy. Recently, the Supreme Court was also informed that it had lost approximately Rs.10 million in interest on the funds collected for the dam[102].

Future awareness drives should instead engage with communities more directly long-term to emphasise the importance of water conservation and judicious use of depleting water resources, whilst targeting the main sectors that are the biggest drain on water i.e. agriculture. In Seattle, USA, a youth education program was conducted that included classroom presentations, watershed tours and curriculum development. A video game was even developed that illustrated the many ways in which water is wasted in the home. As a result of these, and other interventions, there were noticeable savings in water consumption despite a population increase[103]. A similar case study from Zargoza in Spain was also a great success. Where there was a 12 percent increase in the population over a period of 11 years, the city saw a reduction in daily water usage. By engaging directly with the general public through media and educating them on the tangible impact of their water wastage, the citizens of Zargoza were better able to prepare and use water more judiciously. This campaign not only targeted households, but also businesses, parks, and stakeholders. As a result, these water saving concepts have been firmly embedded across all generations and sectors and has "created a genuine water saving culture"[104].

In Pakistan, the next generation are most at risk of the crisis that previous generations are partially responsible for. Therefore, to better equip them to deal with forthcoming challenges, it is important to include these issues in syllabi across the board from the primary to the tertiary level.

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[101] Riaz, A., *Opposing dam can be treason: CJP,* The News, 16th September 2018, www.thenews.com.pk/print/369075-opposing-dam-can-be-treason-cjp [accessed 20th June 2019]

[102] Iqbal, N., *SC losing Rs10m a day as interest on Rs10.6bn collected for dams,* DAWN, 12th June 2019, www.dawn.com/news/1487705 [accessed 30th June 2019]

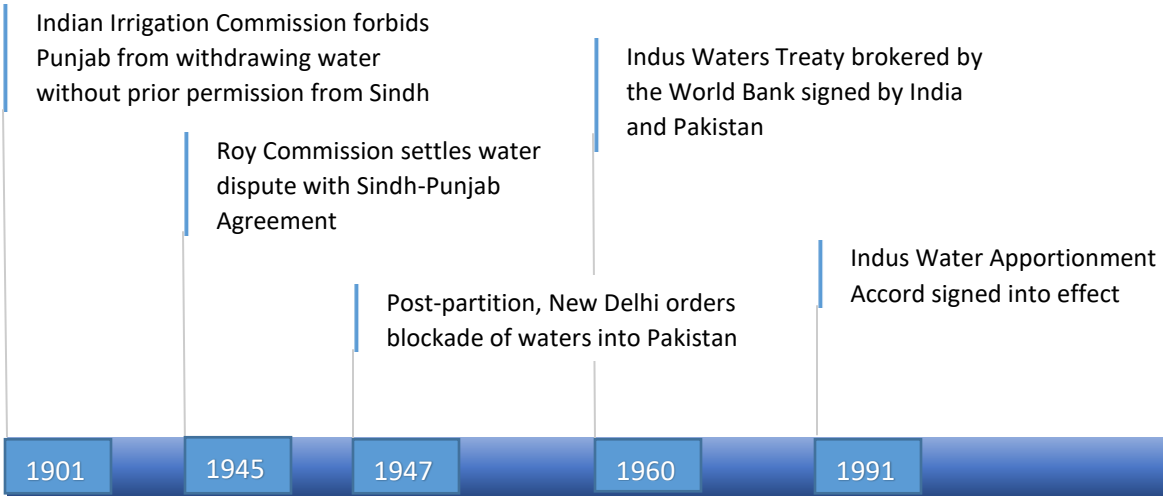
[103] Tindale, M., and Sagris, T., *Managing Water Use in Scarce Environments: A Catalogue of Case Studies,* 2030 Water Resources Group 2013, p.83

[104] Ibid. pp.110-111

Water & Conflict

According to a UN report, in 2017 water played a major role in conflict in at least 45 countries[105]. When considering water and conflict in the region of South Asia, the Indus Waters Treaty (IWT) between India and Pakistan immediately comes to mind. However, the history of disputes and resolutions in and around the Indus River Basin is long and varied. Within Pakistan itself, the Indus Waters Apportionment Accord divides water allocation by province, but long-standing disagreements between Sindh and Punjab are proving to be a constant hurdle in building any infrastructure upriver. The lower riparian province of Sindh feels consistently side-lined and vehemently protests any new infrastructure that they feel would divert or obstruct the already meagre supply of water currently received in the lower river basin. Addressing these problems on both fronts will prove to be a challenge for the federal government but one that must be tackled with the utmost care and urgency.

Brief Timeline of Water Disputes and Resolutions surrounding the Indus River Basin



Indus Waters Treaty 1960:

Pakistan is not the only country that shares its major source of water with a neighbouring state. However, what makes the case more unique is the fact that both nations have constantly engaged in skirmishes, hostilities, and outright war in the brief 70 years since their independence from British rule. In recent years the Indus Waters Treaty has been discussed on both sides of the India-Pakistan border; and not always in a positive light. Indian Prime Minister Narendra Modi in 2016 called for an abolition of the long-standing agreement, causing many to predict a future water war. Although his inflammatory words, "blood and water cannot flow together" ignited concern from many, his threats to withdraw is viewed by some as hollow[106]. Nonetheless, it would be folly to ignore statements made

[105] UNOCHA, *World Humanitarian Data and Trends*, 2018, p.2
[106] Ahmed, H., *Blood and water can't flow together,* Pakistan Today, 1st October 2016, www.pakistantoday.com.pk/2016/10/01/blood-and-water-cant-flow-together/ [accessed 10th June 2019]

by the Prime Minister bearing in mind India's advantage as the upper riparian state and considering the escalation in tensions along the border after India's abrogation of Article 370.

The Indus Waters Treaty of 1960 was signed as a means to protect the national interests of both countries and was the result of a 12-year effort. Under the agreement, Pakistan was awarded unrestricted use of the three Western rivers (Indus, Jhelum, Chenab) while India was given the same authority to use the Eastern rivers (Ravi, Sutlej, Beas)[107]. Previously, India had cut off the supply of water into Pakistan immediately post-partition and, although the flow of water was eventually resumed, Pakistan was liable to pay an annual sum for the privilege of access to this precious resource[108]. Thus, the Treaty came at a necessary time and managed to bring together both nations to resolve their differences amicably.

It is often lauded as an example of successful transboundary resource negotiation that is, so far, standing the test of time. Brokered by the World Bank, the third-party plays the role of mediator in any disagreements regarding the use of rivers by both countries. Critics of the IWT point out that the World Bank has no actual enforcement ability in any dispute cases, it can only put forward recommendations.[109] Recently India's construction of the Kishanganga Dam and continued construction of the Ratle Hydroelectric plant have been a source of contention. Pakistan has made an official appeal, but these issues are, to date, still unresolved[110].

Measures to prevent a water war:

To avoid all eventualities of potential conflict, it is imperative for the respective governments to strengthen bilateral ties and establish foundations that will not be shaken by future political turmoil or meaningless rhetoric. Some would argue that until the matter that lies at the heart of the India-Pakistan dispute is not resolved, we will continue to entertain the possibility of a future water war. Indeed, it was an attack on Indian forces in Kashmir by extremist forces that elicited the controversial statements from PM Modi in 2016. It has been suggested that the clash over Kashmir is not simply over territorial gain of the province but rather gaining control of its water[111]. Robert Wirsing argues that for both countries it remains crucial to gain the upper hand. For India, "abandonment of Kashmir would result in the loss of its upper riparian status and its enormous real-political capacity to intimidate, economically strangulate and threaten the very survival of Pakistan"[112]. Similarly, it would be an equally tempting possibility for Pakistan to gain the upper hand and dominate India.

[107]World Bank, *Indus Waters Treaty,* 1960, Articles II & III
[108] Bauer, P., *Indus Waters Treaty,* Encyclopedia Britannica, 2018, www.britannica.com/topic/Indus-Waters-Treaty [accessed 10th June 2019]
[109]Qureshi, W. A., *Water as a Human Right: A Case Study of the Pakistan-India Water Conflict*, Penn. St. J.L. & Int'l Aff, vol. 5, 2017, p.394
[110] Naqvi, F. *The Kishanganga Conundrum*, DAWN, 18th November 2018, www.dawn.com/news/1445800/the-kishanganga-conundrum [accessed 10th June 2019]
[111] Wirsing, R. *Rivers in Contention*, Heidelberg Papers in South Asian and Comparative Politics, 2008, vol. 41, p.9
[112] Ibid, p.11

Nonetheless, Jeff Nesbitt from the Climate Nexus believes that a water war is an unlikely eventuality, primarily because India would be at the mercy of China. "If China were to look to its own borders near India and were to aggressively pursue water runoff from the glaciers in the Himalayas, it would have a similar effect on India" [113]. Nonetheless, Pakistan cannot and should not hope to safeguard the future of the country's resources based on these assumptions and should instead pursue avenues of peaceful negotiation.

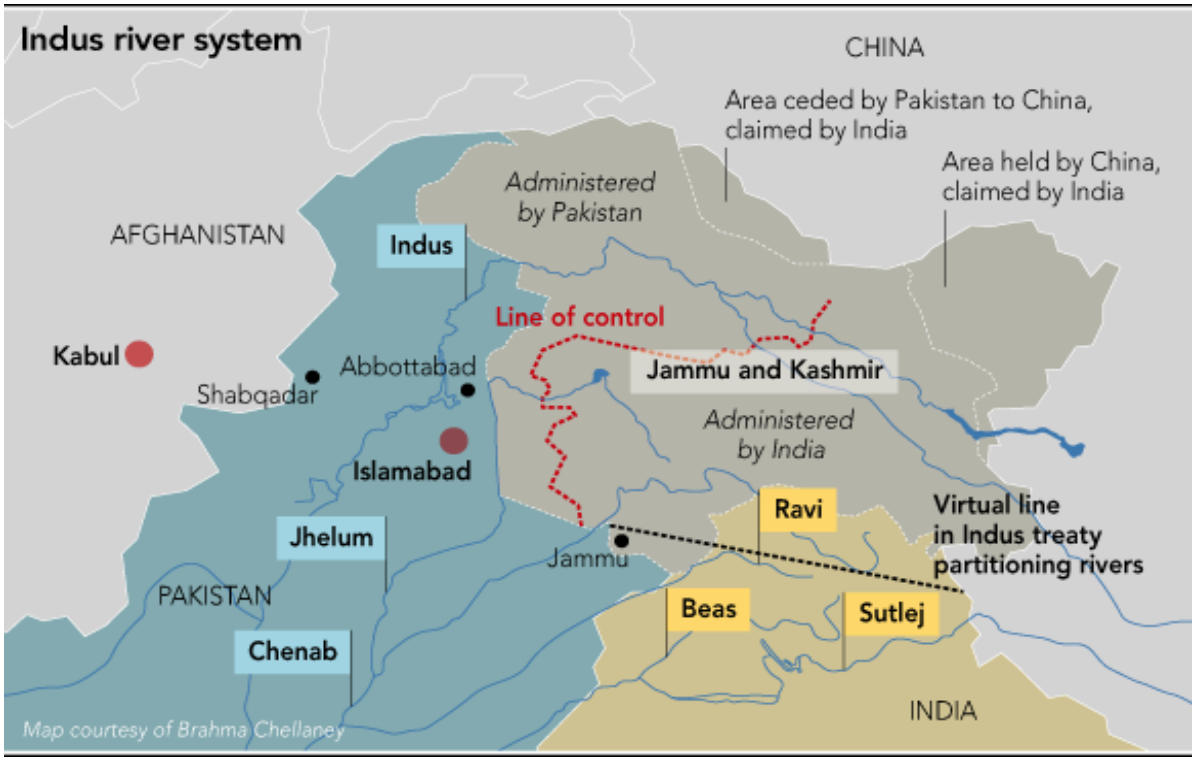
Changing climate, changing realities:

Though the IWT has been integral to maintaining peace in the region, the world as it was known is rapidly changing and will continue to change. Beyond the potential for a conflict between Pakistan and India, it is also important to note that even in times of peace, the volume of water currently extracted from the Indus is unsustainable. At the time of signing the agreement, the threat of global warming was not an immediate concern. With rising temperatures, melting glaciers, and increasing chances of major weather events like flooding and droughts, it is necessary to recognise that the IWT lacks clarity on crucial issues facing us today. This has been observed by individuals such as Senator Sherry Rehman who aptly noted that, "We are now facing challenges brought about by climate change which were not a primary focus during the negotiations for the Indus Water Treaty"[114]. A report by the WWF also reiterates this sentiment, observing that the concept of minimum environmental flows remains unaddressed[115].

Under the agreement, India is prescribed a fixed amount of water for withdrawal from the western rivers. Yet the alarming rate at which the glaciers are melting means that over time the actual volume of water from the Indus river basin will decrease. If India continues to extract the same quantity, it will have a severe negative impact on Pakistan's water resources. Kamal et al postulate, "when flows are variable, how can water entitlements for India be fixed?"[116].

[113] Hall, M., *Water wars: Are India and Pakistan heading for climate change-induced conflict?,* DW, 25th January 2019, www.dw.com/en/water-wars-are-india-and-pakistan-heading-for-climate-change-induced-conflict/a-47203933 [accessed 10th June 2019]
[114] Ibid.
[115] Kamal, Amir, Mohtadullah, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities,* WWF, 2012, Executive Summary
[116] Ibid, p.8

Map 3: Indus Waters Treaty Rivers



[Source: Pakistan Today[117]]

Like Pakistan, India suffers from unregulated over-extraction of groundwater. A recent report declared that 21 cities in India are likely to completely run out of groundwater next year. Chennai has purportedly already dried out its reservoirs completely and is in a state of water emergency. These alarming reports don't bode well for the region. Groundwater extraction is not only negatively affecting the provinces within India where aquifers are being depleted but is simultaneously affecting neighbouring areas and cropland in Pakistan, where aquifers are becoming inundated with brackish water and water levels are declining. This concern was raised in the 11th Five Year Plan[118] yet does not seem to have been pursued as promised and no solutions were provided to mitigate the situation. The IWT does not have any provisions regarding groundwater use, nor does it have any provisions regarding the pollution of rivers. Both these topics are of crucial importance and must be addressed.

Despite its criticisms, many consider the Treaty to be 'sacrosanct'[119]; asserting that its purpose in maintaining stability in the region is far too important to be changed. This view may have merit; however, it is not conducive to peace to ignore the future. To quote an ADB report on water security, "It should be realized under a rapidly changing Asia, that tomorrow's water problems can no longer

[117] www.pakistantoday.com.pk/2017/01/26/world-bank-reassures-mediation-over-indus-waters-treaty/ [accessed 10th June 2019]
[118] Pakistan Ministry of Planning, Development & Reform, *11th Five Year Plan 2013-2018*, p.229
[119] Kamal, S. et al, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities*, WWF, 2012, p.8

be identified, let alone solved, with today's knowledge and yesterday's experience"[120]. Some argue that the way forward is to strengthen and improve the Permanent Indus Commission, which was established as a channel of communication between the two nations through their representative commissioners[121]. This is certainly worth developing, however unless enshrined in the IWT or in its amendments, any changes in the current state of affairs will be hard to enforce. In principle, the IWT should remain the same to prevent new disagreements from arising. Adding amendments or clauses that benefit both states, considering current and future circumstances, should be prioritised. Opposition to further amendments from both sides of the border can be minimised by proposing changes that are mutually beneficial e.g. a variable cap on water extraction from eastern and western rivers dependent on environmental flows. These amendments should be drafted with non-partisan consultants to ensure transparency and objectivity. The Indus Basin is now at risk from a multitude of recognised 'modern' threats that include climate change, financial crises, energy crises, population growth, and more[122].

Indus Waters Apportionment Accord 1991:

Within Pakistan, the Indus rivers and its tributaries support ecosystems, agriculture, and industry across the four provinces before flowing out into the Arabian sea. Historically, however, there have been several major disputes between Punjab and Sindh. Punjab, as the upper riparian state, has the advantage in the flow of water it receives. Sindh, at the tail end of the river and irrigation system, does not have access to the same volume of water and therefore vehemently opposes any construction upstream that impedes river flow downstream. The Indus Water Apportionment Accord of 1991 set an allocation on the volume of water received by each province. Yet it wasn't the first of its kind.

In 1901, the Indian Irrigation Commission prevented Punjab from withdrawing water from the canals without prior permission from Sindh. The Viceroy of India, Lord Reading, in 1925 rejected plans for the construction of the Thal Canal on the grounds that the lower province required the water[123]. A further dispute was resolved when the Roy Commission in 1941-1945 drew up the Sindh-Punjab agreement, where the latter province was directed to contribute approximately Rs. 20 million at the time for the construction of two barrages in Sindh[124].

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[120] Asian Development Bank (ADB), *Asian Water Development Outlook,* 2007, p.22
[121] Akhtar, S. *Managing Shared Basins – Opportunities & Challenges in Implementation of the Indus Water Treaty,* Leading Perspectives, 23rd February 2018, www.lead.org.pk/talks/talk11.htm [accessed 10th June 2019]
[122] Kamal, S. et al, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities,* WWF, 2012, Executive Summary, p.8
[123] Azam, S. and Khimani, Z., *Sindh's attitude towards Kalabagh Dam – I,* Business Recorder, 27th September 2007, https://fp.brecorder.com/2007/09/20070927628608/ [accessed 10th June 2019]
[124] Palijo, R. B., *Sindh Punjab Water Dispute 1859-2003,* Center for Peace and Civil Society, 2011, p.15

Table 3: Provincial water allocation – Indus Water Apportionment Accord

Province	Seasonal Allocation of Water Resources (Million Acre Feet)
Punjab	55.94 MAF
Sindh	48.76 MAF
KPK (formerly NWFP)	5.78 MAF
Balochistan	3.87 MAF
Ungauged Canals	3.00 MAF
TOTAL	**117.35 MAF**

[Source: Indus Water Apportionment Accord]

The role of drought in helping ignite the civil war in Syria has been well documented[125]. Although far from civil war, the federal government must take care to monitor any malcontent in the provinces to ensure that in times of future instability, the groundwork for conflict is not laid. A World Bank report affirms this, warning that a "lack of resilience" in Pakistan, particularly with regards to droughts, could lead to conflict between provinces and sectors over their share of water[126].

Like Punjab, the Sindh province has an unhealthy dependence on its fast-depleting groundwater resources. Farmers in the lower Indus basin complain about the low volume of water their cropland receives through the canal system. To compensate for the lack of water, and because of the subsidies available for unregulated tube wells, they pump freshwater from underground. As a result, in areas close to the sea, coastal aquifers have become polluted by saltwater, drastically reducing the quality of water and rendering vast swaths of agricultural land – almost 2 million acres – unfit for cropping[127]. The construction of various channels, barrages and dams has reduced water discharge by approximately one fifth into Sindh and the formerly rich mangrove forests and natural fisheries are now disappearing.

Misinterpretation and mistrust:

One of the main issues that faces the Accord is of interpretation. For example, Punjab believes that section 6 allows for the construction of dams (currently Kalabagh and Diamer-Bhasha), however the other provinces protest that further storage reservoirs upstream will bring about reduced flows downstream. In a similar case, Sindh protests the construction of the Greater Thal canal which they believe will divert the flow of water. Punjab contends that under the remit of the Apportionment Accord, it is their right to develop water-related projects within their share. The lower riparian province feels it likely that once the canal is set up, farmers and landowners will abuse their share of

[125] Iceland, C., *Water Stress is Helping Drive Conflict and Migration: How Should the Global Community Respond?*, WRI, www.wri.org/news/water-stress-helping-drive-conflict-and-migration [accessed 31st May 2019]
[126] Young, W. Anwar, A. et al., *Pakistan: Getting More from Water*, World Bank, 2019, p.xx
[127] Pakistan Ministry of Water Resources, *National Water Policy*, 2018, p.27

water and take more than is allowed as per the accord[128]. This can only be prevented through strengthening water management institutions and imposing appropriate fines and punishment to act as a deterrent.

The current language of the Apportionment Accord has been criticised for not affording proper clarity on important matters. Its clauses and terminology are ambiguous, allowing for Punjab to interpret the figures in Clause 2 as 'notional' whereas Sindh argues they are absolute[129].

At the time of signing the accord, representatives from each province agreed upon the need for a minimum flow to the sea. However, they failed to come to a consensus on the exact quantity required; deferring the decision until further research was conducted. The signatories were also not bound to the findings of any commissioned study nor did they present guidelines on how such flows might be incorporated into the existing framework. The fact that the accord does not have any clearly stated objective also contributes to uncertainty over whether it has fulfilled the goals envisioned at the time[130].

Finding an equitable way forward:

As with the IWT, it would be prudent to revisit the provincial agreement in light of new research and information that directly affects the Indus basin as a whole. For example, the concept of environmental flows – which are necessary to maintain a balance for ecosystems along rivers – is absent from the agreement, as are mentions of pollution[131]. A regular, controlled flow is needed each year, guaranteed through strict regulation and implementation. This should reflect the seasonal requirements and the flows necessary for maintaining a healthy and functioning river ecosystem[132]. Amendments should be drafted in consultation with stakeholders from each province, private institutions, and professionals in the field, particularly since there is a great deal of mistrust due to the lack of transparent water-sharing.

Briscoe and Qamar suggested the installation of a telemetry system at canal headworks and barrages in order to monitor the volume of water that is being withdrawn and to ensure that each provinces' entitlement is met. This data can also be made public so farmers at each section of the river basin are aware of the quantity they will receive and when they will receive it. It will allow for increased transparency and the burden of equitable distribution will be placed on the irrigation system authorities who can be held accountable[133]. The introduction of this system had also been put forward by water institutions to prevent water theft. An article from late 2018 reported that the current government has

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[128] Kamal S. et al, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities*, WWF, 2012, p.11

[129] Anwar, A., *Talk 29 Pakistan's Water Apportionment Accord of 1991: 25 Years and beyond,* Leading Perspectives, 29th November 2018, www.lead.org.pk/talks/talk29.htm [accessed 10th June 2019]

[130] Ibid.

[131] Anwar, A. *Pakistan's Provincial Water Disputes: a way forward,* DAWN, 2016, www.dawn.com/news/1273760 [accessed 10th June 2019]

[132] Kamal, S. et al, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities*, WWF, 2012, p.10

[133] Briscoe, J. and Qamar, U., *Pakistan's Water Economy: Running Dry,* World Bank, 2005, p.21

initiated the project[134] and is likely to have been completed at this time. This system would help furnish institutions with much-needed data on current water resources and provide an opportunity to compile a centralised database; reducing the chances of inappropriate policy and agenda formulations at the national level[135]. A further upgrade to the telemetry system should eventually allow for monitoring regular basin *inflows* as well as outflows. This would allow water management bodies to more accurately determine how much water is returning to the basin and how much is being lost in consumptive use[136].

The Orange-Senqu Basin in South Africa also suffers from wasteful and unproductive water usage. In an effort to curb these problems, several solutions were implemented. Alongside clear rules and regulations, there was "strict enforcement of water allocations, and scheduling". Pakistani water management bodies from across the provinces must come together to decide upon suitable water allocations based on the actual flow of water that the Indus basin receives in the year. These then need to be enforced through strict management and legislation[137].

A good example of inter-province water-sharing and extraction is the Murray-Darling Basin Agreement of 1992 in Australia. The agreement placed a cap on the amount of withdrawals from the river basin in a particular state. This not only allows for a fixed outflow but also inherently places a value on the volume of water that can be extracted and emphasises the need for responsible and judicious water use[138]. It is important to note that placing a cap on water withdrawal without accounting for minimum environmental flows is flawed. In order to provide the most equitable solution that anticipates future challenges, all factors must be taken into account. A cap on water withdrawal which factors in minimum environmental flows for each district is the way forward.

It has also been proposed that a National Water Council should be formed that can effectively facilitate collaboration across provinces and determine long-term social, environmental, and economic objectives. These objectives will allow for uniform and coordinated management across the whole Indus Basin and potentially act as a barrier to further conflict[139].

Conclusion:

According to the World Economic Forum's Global Risk Report, water crises have been ranked among the top-five risks in terms of impact for eight consecutive years[140]. Thomas Homer-Dixon maintains

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[134] Jabri, P. *Telemetry system being installed to control water theft,* Business Recorder, 21st November 2018, www.brecorder.com/2018/11/21/453910/telemetry-system-being-installed-to-control-water-theft/ [accessed 10th June 2019]

[135] Pakistan Council of Research in Water Resources, *National Research Agenda on Water 2016-2025,*

[136] Tindale, M., and Sagris, T., *Managing Water Use in Scarce Environments: A Catalogue of Case Studies,* 2030 Water Resources Group 2013, p.21

[137] Ibid. p.28

[138] Kamal, S. et al, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities*, WWF, 2012, p.74

[139] Young, W. Anwar, A. et al., *Pakistan: Getting More from Water,* World Bank, 2019, p.xxiii

[140] Heijden, K. and Stinson, C., *Water is a Growing Source of Global Conflict. Here's What We Need to Do,* WRI, 19th March 2019, www.wri.org/blog/2019/03/water-growing-source-global-conflict-heres-what-we-need-do [accessed 10th June 2019]

that, "resource stress…multiplies the impact of a society's existing vulnerabilities, including its ethnic cleavages and skewed distribution of land, wealth and power"[141]. Pakistan cannot afford an exacerbation of its current woes, which are likely to be amplified by a scarcity of water. The problems that have arisen recently in both international and intranational treaties are highlighted as a result of new research and studies that can more accurately predict the fate of our natural resources. It would be a grave error to ignore these new findings for the sake of preserving agreements that very soon will become irrelevant to the realities of the day.

In both treaties, technical issues need to be isolated from political situations[142]. As an example; there are few similarities between the Turkey-Armenia water sharing agreement, and the India-Pakistan one. However, a crucial lesson learnt is in good intent and mutually beneficial cooperation. Droughts in Turkey and Armenia were handled with compassion and creativity on both sides, with a combination of alternating water supply and sharing water-saving practices[143]. Therefore, mutual understanding and compassion should be the way forward to reduce the need for invoking the World Bank's arbitration powers with regards the IWT.

It is apparent that neither Sindh nor Punjab have access to surplus amounts of water[144]; both provinces suffer from largescale groundwater depletion and inefficient water usage practices. The present water sharing arrangements are not "economically optimal" nor are they flexible enough to deal with later challenges in water security[145]. Although necessary, changes will be hard to implement, particularly when political apathy has plagued the water sector. A WWF report fittingly states that since economic gain is separate for each province in Pakistan, there is unlikely to be a joint effort to work towards a common goal. The only solution for this remains to make "benefit sharing the corner-stone of all future water resources development initiatives"[146]. Through benefit sharing, separate provinces and institutions within the Indus Water Apportionment Accord will be more inclined to work towards a sustainable, mutually beneficial solution.

With global political tensions on the rise, it can become easy to ignore problems that feel relatively far away. But if immediate action isn't taken, the government cannot hope to solve the problems that Pakistan will face as a result of climate change. Long-term planning is key in order to ensure the future stability of the country. All countries will not suffer in the same way due to a global water crisis. Indeed, there is no uniform water crisis, rather different countries and regions within countries are likely to face different problems due to water scarcity. Therefore, local and international decisions on mitigating the water security situation and on water management must take into account the

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[141] Homer-Dixon, T., *Straw Man in the Wind,* The National Interest, 2nd January 2008, https://nationalinterest.org/article/straw-man-in-the-wind-1921 [accessed 13th June 2019]
[142] Altingoz, M. *Talk21 Lessons for Pakistan from Turkey-Armenia Water Agreement,* Leading Perspectives, 31st July 2018, www.lead.org.pk/talks/talk21.htm [accessed 13th June 2019]
[143] Ibid.
[144] Kamal, S. et al, *Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities,* WWF, 2012, p.27
[145] Young, W. Anwar, A. et al., *Pakistan: Getting More from Water,* World Bank, 2019, p.133
[146] Ibid. p.18

"individual characteristics of each basin and location within the basin", whilst also considering other socio-economic demands[147].

[147] Tindale, M., and Sagris, T., *Managing Water Use in Scarce Environments: A Catalogue of Case Studies,* 2030 Water Resources Group 2013, p.9

Conclusion

According to a world economic outlook report, water scarcity is the biggest threat to Pakistan's economy.[148] The three main dimensions that characterize water scarcity are[149]:

1. A physical lack of water availability to satisfy demand;
2. The low level of infrastructure development that controls storage, distribution, and access;
3. The lack of institutional capacity to manage the use of water and provide necessary water services.

Pakistan ticks the boxes in all three categories. It is now understood by government and private institutions alike that it is of paramount importance to protect our natural water resources; whether from natural disaster, or from human carelessness. The government would be well advised not to take any decisions without fully understanding the scope and impact on water storage, conflict, and usage on the international, and national level. UN Humanitarian Coordinator for Pakistan, Neil Buhne stated, "no person in Pakistan, whether from the north with its more than 5,000 glaciers, or from the south with its 'hyper deserts,' will be immune to this [scarcity]"[150].

It has been calculated that the minimum water requirement to avoid food and health implications is at least 1000 cubic metres per capita per year.[151] An example provided by the International Institute of Sustainable Development states that the annual water available for each person in the country would not even fill half of an Olympic swimming pool.[152] Pakistan is already dangerously close to falling below this number. It is clear that water management bodies are falling short in their responsibilities to ensure that existing laws are followed and in implementing necessary reforms. Further action should ensure that water resources are well managed at the provincial and federal level in order to sustain economic growth and maintain the health of the general populace.

1. The use of water is intrinsically linked to water storage and water and conflict. Over extraction of groundwater and inefficient methods of irrigation lead to an unequitable share of water divided amongst farmers at each part of the river basin. Industry and domestic usage of water is leading to widespread pollution and increasing the risks of water-borne diseases among urban and rural populations. A few suggestions for improving **water usage** include:

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[148] Samaa, *Water scarcity is the biggest threat to Pakistan's economy: WEF report*, 25th November 2018, www.samaa.tv/news/2018/11/water-crisis-is-the-biggest-risk-to-pakistans-economy-wef-report/ [accessed 2nd June 2019]
[149] FAO, *FAO Water Reports - Coping with water scarcity: An action framework for agricultural and food security,* 2012, p.7
[150] Baloch, S. M., Water Crisis: Why is Pakistan running dry?, 7th June 2018, www.dw.com/en/water-crisis-why-is-pakistan-running-dry/a-44110280, [accessed 31st May 2019]
[151] Pakistan Ministry of Water Resources, *National Water Policy,* 2018, p.
[152] Parry, J. et al., *Making Every Drop Count: Pakistan's growing water scarcity challenge*, IISD, 29th September 2016, www.iisd.org/blog/making-every-drop-count-pakistan-s-growing-water-scarcity-challenge [accessed 31st May 2019]

- Farmers and provincial water and irrigation bodies (IRSA etc.) must determine appropriate water requirements for each crop in order to efficiently irrigate them through less wasteful methods, e.g. through drip and sprinklers. This will also create awareness about the 'more crop per drop' philosophy that produces higher crop yield for less water input. They must also be educated on the benefits of other cropping methods such as land-levelling and scheduling irrigation.

- The concept of 'virtual water' can be introduced where the value of a crop is derived from the amount of water used to produce it, rather than based on a uniform pricing system that doesn't accurately reflect the volume of water that goes into producing a crop.

- A general shift in the current attitude of water institutions has to occur; from water supply to water demand.

- Tariffs and the *abiana* prices must be revised for both groundwater and canals. A future tiered metering system can also be considered for households as a deterrent to consuming excessive amounts of water.

- A cap should also be introduced on surface water along with the installation of a telemetry system that accounts for minimum environmental flows. It will allow for those who abuse the system to be caught and fined. This system can be upgraded to systems across the globe where river basin inflows are also monitored in order to determine net basin benefit.

- The potential for a 'water bank' – through which farmers can sell off excess water allocation and buy as required – should be discussed by water management bodies in each province. This could allow for inter-provincial sharing and mitigate the issues surrounding water and conflict. The South Africa Orange-Senqu basin credits the reduction in water consumption to their virtual water bank[153].

- Subsidies can be introduced on energy generation specifically used for efficient irrigation methods that normally would cost too much to implement e.g. drip irrigation.

- Canals must be appropriately lined and upgraded, however in areas where groundwater levels are low, water should be allowed to seep into the ground as a means to artificially recharge the aquifer.

- Groundwater resources must be monitored, and necessary data collected. A cap on water withdrawals must be placed in order to ensure that water table levels don't become

[153] Tindale, M., and Sagris, T., *Managing Water Use in Scarce Environments: A Catalogue of Case Studies,* 2030 Water Resources Group 2013, p.29

dangerously low. Those responsible for over-extraction must be fined. Tube-well installation must also be carefully assessed and regulated.

- Farmers must be incentivised to plant more adaptive crops that can weather droughts and low soil and water quality conditions.

- Waste-water treatment plants must be constructed that can aid energy generation and produce fertiliser for agriculture. Alternate water sources e.g. reclaiming effluent for irrigation, should also be considered for agricultural purposes.

- Industries must be strictly monitored to ensure minimal pollution into waterways – particularly from the leather and textile businesses. Those found in violation of these laws must be fined heavily in order to prevent further degradation of the already fragile river ecosystem. Farmers that use harmful and polluting pesticides must also be discouraged and fined.

- Public-private partnerships must be encouraged where robust solutions to water wastage are provided with financial backing in targeted areas.

- Tax collection on the agriculture sector should be enforced, especially considering the contribution of this sector to Pakistan's GDP. Fines must be imposed on those who do not pay the required amount.

- In the long term, it is likely that tenancy laws will need to be reformed in order to implement necessary changes that don't simply benefit wealthy landowners, but sharecroppers and farmhands too.

2. Inadequate storage facilities and recurring flooding has led to Pakistan losing approximately $90 billion since 2010. This does not account for the damage to livestock, crops, and infrastructure[154]. In **water storage**, the following changes can be suggested:

    - In light of all current information available and the difficulties present, the government would be advised to weigh the political and geographical issues surrounding the Diamer-Bhasha and the Kalabagh dams and propose a realistic way forward. The government must commit wholeheartedly to building a large water storage dam immediately.

    - The current reservoirs, barrages, and dams must continue to be upgraded and technology must be developed to remove sediment and polluting substances from freshwater bodies.

[154] Shahid, J., *'Pakistan has lost $90 billion worth of water due to floods since 2010',* DAWN, 27th April 2018, www.dawn.com/news/1404090, [accessed 20th June 2019]

- In the short-term, small, medium, mini, and subsurface dams must be constructed to mitigate the immediate effects of climate change and water scarcity in the provinces. Investments from the private sector should also be encouraged.

- It is evident that dams built closer to the sea or downstream (e.g. in Sindh) would be far more viable an option in order to increase net basin benefit as they are responsible for storing water that would otherwise be lost to the sea or help prevent further water quality degradation through saltwater intrusion.

- As a long-term solution, the status of Kashmir and Gilgit-Baltistan must be determined in order to allow for the construction of water infrastructure in the region where there is high flow of water.

- Assurances that are made by provinces regarding equitable distribution of water and reimbursement to displaced families must be followed through. In order to do this, all information should be publicly available so government institutions can be held to account.

- Effective, non-partisan awareness campaigns must be conducted that do not rely solely on donations, and the topic of water crises must be explored at all levels of education (primary, secondary, tertiary). Targeted awareness campaigns should also be executed in sectors that pollute and waste the most water.

- The environmental and human impacts of all water storage projects must be assessed thoroughly with an appropriate consensus reached after analysing the trade-offs.

- Any large or small dams that are constructed must go through rigorous planning and research to understand the complexities of the area; preventing the chances of building structures that are either inadequate or inappropriate.

- Structures in at-risk areas (e.g. high chances of seismicity) must be reassessed in light of new research and findings.

- Large dams in particular need to have their predicted budgets calculated to ensure that costs are not underestimated; as they usually have been in most cases.

3. There is some overlap between water storage and conflict, particularly as it relates to the disagreements between Punjab and Sindh over water sharing. Reports from across the border in India on severe water shortages are concerning, especially since there is only a single source of

freshwater in Pakistan. Moreover, in terms of disputes, the World Bank has no capacity for enforcement under the Indus Waters Treaty. With **water and conflict**, it is imperative for the following to be considered:

The Indus Waters Treaty:

- Pakistan must make efforts for further amendments to be added to the IWT to ensure they are as binding as the rest of the signed agreement. These must address issues such as pollution of rivers, groundwater extraction, and variable flows, so that the respective countries are adequately adapted for future challenges. Both nations will be less opposed to changes as long as they are mutually beneficial. With increasingly war hungry governments, this is the most prudent way in which to guarantee future water security.

- The Permanent Indus Commission should be strengthened so there is more direct communication between India and Pakistan without having to constantly appeal to the World Bank for intervention. Political relations must be strengthened to ensure that disagreements over other issues don't impact the Treaty.

- Both India and Pakistan must move forward with good intent and prepare for the long-term situation brought about through climate change. Mutually beneficial cooperation must also be encouraged. It would be wise to learn lessons from other countries e.g. Turkey/Armenia.

The Indus Waters Apportionment Accord:

- With regards the Indus Waters Apportionment Accord, new clauses must be added that adequately address the concerns of various provinces and changing times. Clarity must also be provided over misinterpretation of existing clauses.

- Similar to the Murray-Darling basin, a cap should be introduced on withdrawals within each province that also accounts for minimum environmental flows downstream to guarantee healthy ecosystems. The newly installed telemetry system will be a valuable aid in determining the volume required, and to keep a check on withdrawals in a certain area.

- Trust-building at the provincial level is essential but it is the federal government that must overcome these hurdles and push for necessary reforms.

- If benefit-sharing becomes the foundation of all future reforms, stakeholders will be more inclined to participate in and accept changes, as long as they don't feel disadvantaged.

- Long-term planning and solutions must be decided and implemented now. These should continue, regardless of which political party is in power.

Net basin benefit:

A 2030 Water Resources Group catalogues the various ways countries have sought to tackle their water scarcity problems. However, contrary to other methods that determine the success of an initiative (e.g. through monitoring withdrawals from the basin), the case studies are looked at through the lens of overall consumptive use and net basin benefit. For example, although more water-judicious irrigation methods put less strain on water withdrawals, more water is used consumptively as a result of greater efficiency. Therefore, less water is allowed to seep into the ground to recharge aquifers and less water flows back into the basin through water canals. By increasing irrigation efficiency whilst also pushing for higher crop yield, the effects on consumptive use can be negative. The report argues that reductions in consumptive use have the "greatest potential to positively impact basin water scarcity"[155].

We must ensure that future generations do not pay for our – easily rectifiable – mistakes. It is clear that in order to solve future problems, a more holistic approach is required that considers the links between food, energy, the environment, and industry[156] and their interaction with water usage, storage, and conflict.

Despite the many obstacles before us, it is of paramount importance that progress be made before it is too late. Professor Asit K. Biswas believes that if developing countries in Asia face a water crisis, "it will not be because of physical scarcity of water, but because of inadequate or inappropriate water governance, including management practices, institutional arrangements, and socio-political conditions, which now leave much to be desired."[157]

[155] Tindale, M., and Sagris, T., *Managing Water Use in Scarce Environments: A Catalogue of Case Studies,* 2030 Water Resources Group 2013, pp.9-10
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