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NUST INSTITUTE OF POLICY STUDIES

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REPORT OF THE ROUNDTABLE DISCUSSION  
ON

**MANAGING THE WATERS:  
APPRAISAL OF PAKISTAN'S  
PROBLEMS AND WAYS  
FORWARD**



NUST INSTITUTE OF POLICY STUDIES (NIPS)

## **Report of the Roundtable Discussion on Managing Waters: Appraisal of Pakistan's Problems and Ways Forward**

### **Compiled By**

NUST Institute of Policy Studies (NIPS)

### **Published By**

NUST Institute of Policy Studies (NIPS)

National University of Sciences and Technology

H-12

Islamabad

[www.nust.edu.pk](http://www.nust.edu.pk)

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## 1. Introduction

NUST Institute of Policy Studies (NIPS), organized a high-level roundtable, “Managing the Waters: Appraising the Problems and Ways Forward”, on the water crisis of Pakistan on October 23, 2019. The roundtable dealt in detail with the problems and challenges associated with national water resources development, management, and governance.

Water experts, professionals, policy researchers, academics, and students attended the roundtable. Renowned experts from Balochistan, Punjab, and Sind were also present.<sup>1</sup> The roundtable consisted of two major issue-based presentations followed by an interactive discussion in which the participants shared their views on various aspects of the topic under deliberation.

In his opening remarks, Lieutenant General Naweed Zaman (Retd.), Rector NUST and Patron NIPS, stated that the inefficient use of water across the board had, among other things, caused Pakistan to become a severely water-stressed country. He said the current unsustainable patterns of national water use, if not revised radically, could make Pakistan water-scarce in future. He said the cost of poor water management was substantial, which, according to the World Bank, was USD 12 billion dollar annually. He advised that a water-saving approach required to be promoted at all levels of society.

Rector NUST highlighted the contribution of NUST to awareness-raising through regular community and youth initiatives aimed at efficient water consumption by individuals and households. He said a multi-partisan

implementation of the national water policy targeting multiple areas of intervention for sustainable water management was needed to achieve and ensure water security.

Engineer Suleman Najib Khan, noted water expert of Pakistan and one of the most well-informed and vocal advocates for harnessing the immense hydel potential of the Indus River System, in his meticulously researched presentation, exposed India’s blatant water aggression as well as the flawed nature of the 1960 Indus Waters Treaty (IWT) which, in his estimation, was never meant to be a Pakistan-friendly treaty. In highlighting its disadvantageous aspects, he stressed that the treaty amounted to a little more than the legalization of the theft of water by India that by right belonged to Pakistan.

He said this state of affairs was further compounded by the inflow of untreated sewage from India that was polluting the country’s underground water as well as causing the spread of water-borne diseases like hepatitis. He warned that a combination of the traditional lack of knowledge, commitment, and seriousness on the part of the national water managers continued to undermine the national interest of Pakistan.

Engineer Suleman called for a proactive evidence-based national and international outreach campaign for raising the level of awareness of policy makers, general public, and global community about India’s unrestrained misappropriation of Pakistan’s waters. He recommended that a Commission for Indus Basin Strategic Analysis (CIBSA), first proposed during the National Conference on Reservoirs at Islamabad in February 1998, needed to be

1- See Appendix 4 for the participants of the roundtable.



formed for functional R&D in the water sector together with a Pakistan Energy Planning and Execution (PEPE) entity.

Dr. Muhammad Ashraf, Chairman Pakistan Council of Research in Water Resources (PCRWR), presented the problems of Pakistan's inland water resources. He said Pakistan had the fourth largest groundwater resources in the world after India, the U.S., and China but it was not the best managed. He said over 90 percent drinking water and 100 percent water for industrial use comes from groundwater. This massive water resources system was suffering from major inefficiencies.

Major water-sector issues were related to: water resources development consisting of growing water scarcity, recurrent floods, inadequate storage facilities, sedimentation in storage reservoirs of about 0.2 MAF per year, and unutilized potential of 18 MAF; water resources management consisting of low systemic efficiency of less than 40 percent, low productivity per unit of water, groundwater depletion and degradation, disposal of drainage effluent of 10 MAF, and waste water management; and water governance issues consisting of low water pricing, zero groundwater regulatory framework, and lack of crop zoning.

Dr. Ashraf said the construction of small and medium dams was needed along with large dams. He said there was a further need to increase water use efficiency by at least 30 percent by producing more crop per drop through use of new technologies like drip and sprinkler irrigation on the one hand, and more realistic water pricing policy on

the other.

He said there needed to be a comprehensive regulatory framework for sustainable water resources utilization together with reduction in water wastage, theft and non-revenue water allocation through 100 percent metering for drinking water supplies, creation of crop ecological zones, and establishment of provincial authorities including province-level groundwater authorities. There was also a need, he opined, to think of ways to transfer water from wet to dry seasons.

Other recommendations included the urgent need for the depoliticization of water issues in Pakistan, the setting up of up-to-date water monitoring systems, the plugging of water demand-supply gap, the formulation of water recharge strategies, dynamic and aggressive water diplomacy, formation of public-private partnerships in different areas of water management, etc.<sup>2</sup>

2- See Section 3 for recommendations.



## 2. Roundtable Discussion

### 2.1. Opening Remarks

Lieutenant General Naweed Zaman HI (M) (Retd.) – Rector NUST and Patron NIPS



Opening Remarks: (From the left) Lieutenant General Naweed Zaman HI (M), (Retd.), Dr. Muhammad Arshad and Dr. Ashfaqe Hasan Khan (NUST Archive, 2019)

The presence of renowned water experts, government officials, and environmentalists, representing key national and international organizations and hailing from different parts of the country, is welcome. It is pleasing to note the senior representation from Balochistan, Khyber Pakhtunkhwa, Sind, and Punjab. A warm welcome is extended to all the worthy attendees on behalf of NIPS. The subject of water is crucial to Pakistan's national development. This roundtable seeks to create an impact in order to facilitate the process of forming effective policies with regard to the management of Pakistan's

water resources.

Pakistan is said to be 23<sup>rd</sup> among 167 countries facing water shortage. Its annual per capita water availability is also said to have fallen below 1000 cubic meters, the global benchmark for assessing water shortage. Whereas, the internationally recognized average annual water availability per person is set at 1800 cubic meters, Pakistan's average annual per capita water availability is estimated to be 935 cubic meters. This situation is especially dire when it is taken into account that Pakistan is a



populous agricultural country. Pakistan has one of the world's largest water basins but it is not being utilized optimally.

The cost of poor water management is substantial, which, according to the World Bank, is USD 12 billion dollar annually. Ineffectual management of water resources and the lack of comprehensive predictive water planning have contributed to the water woes of Pakistan. Furthermore, there is also a lack of effective water regulation policies and standards combined with the absence of basic water awareness. The first step toward formulating sustainable solutions to the problem is to highlight the importance of the water-use efficiency. For instance, print and electronic media should be utilized to launch a nation-wide campaign for raising water-related awareness of the people of Pakistan. The potential of social media can also be harnessed to reinforce this awareness-raising campaign. This can help people become conscious and concerned with respect to water management and conservation at different levels, but primarily at individual and household levels. Whole urban and rural communities can also rethink their attitude to water as shown in their private and public consumption of this fundamental resource. It is pleasing to note that NUST continues to play its part through undertaking water awareness campaigns, walks, and competitions. The university students work with communities, and, especially, schools, to help the youth realize the crucial importance of adopting an across-the-board water-saving approach. The university students have so far reached out to 150 schools in Islamabad and Rawalpindi as part of this efficient water-use campaign. At the policy and governance levels, there is a need to formulate and implement a multi-partisan comprehensive

water management and conservation policy that is scientifically and technically sound, politically acceptable, economically feasible and profitable, socially responsive, and culturally aware.

## 2.2. Remarks of the Roundtable Moderator

### Dr. Muhammad Arshad – Co-Founder and CEO of NEW Con. (NC), Consultancy for Water and Environment

As the world's fifth largest nation in terms of population and an agro-economy, Pakistan's growing population and water demand places the country in a tough situation. A key challenge is to meet stresses relevant to food security and water supply at domestic level. There is an inexorable crisis in this area. It is because water is a diminishing resource and cannot be generated the way energy is produced that its use should be judicious. The National Water Policy of Pakistan 2018 outlines strategies and provides recommendations to the provinces on their action plans, but awaits implementation. It is, therefore, pertinent to involve think tanks and other relevant institutions to work at full potential for achieving win-win outcomes.





## 2.3. Presentations

### 2.3.1. The Impact of Indus Waters Treaty (IWT) on Pakistan

Engineer Suleman Najib Khan – Vice President, Institution of Electrical and Electronics Engineers Pakistan (IEEEP)



Engineer Suleman Najib Khan (NUST Archive, 2019)

#### Flawed Nature of the IWT

Water resource management and the implementation of viable policies in this regard is crucial to our continued existence and indispensable in the quest for national prosperity. As is well-known, water security is a subset of national security. According to the National Geographic Society, about three-fourth of global occupations are based on water in one way or the other. Short shrift given to this area can be nationally suicidal. It is, therefore, need of the hour to organize

prudent and massive deliberations on this subject. These deliberations need to be broad-based involving the input of experts, thinkers, and practitioners in multiple domains but above all they should be based on ensuring that experts and professionals of incorruptible integrity with an in-depth knowledge of the real issues should lead this process.

Indian mala fides and unregenerate enmity toward Pakistan have always formed a major part of our water problems. For instance,



once India got possession of Madhopur and Ferozepur Headworks in 1947 after the independence of the Subcontinent, it sporadically began to close the flow of Ravi in 1948 so that the crop cycle in West Punjab, i.e. Pakistan, could be disrupted and damaged. India's attitude has always been one of non-cooperation and aggression against Pakistan.

The roots of many of Pakistan's current problems primarily are linked to the 1960 Pakistan-India Indus Waters Treaty (IWT). Contrary to the so-called win-win solutions the treaty was supposed to create, it has turned out to be a historical folly which deprived Pakistan of the three Eastern Rivers (Beas, Ravi, and Sutlej) which were crucial for our national development. One can reasonably go so far as to claim that this treaty did not turn out to be anything but a license for India to drain its four sewers (Hudiarra Drain, Kasur Nullah, Salimshah Drain, and Fazilka Drain) into Pakistan.<sup>3</sup>

### **Lack of Appropriate Policy Expertise on the Pakistani Side**

Unfortunately, that intent could not be calculated by Pakistani decision-makers at the time. This illustrates one of the standing problems of the state and polity of Pakistan, i.e., dearth of competent policy- and decision-makers. Furthermore, there was a lack of a scientific approach based on evidence and data that could deal with Indian water theft before and after the IWT came into force. The consequent blind spots in our policy design and decisions only encouraged the Indians to work with impunity toward the blatant misappropriation of our water resources.

Our problems have been compounded by the fact that while Indian water negotiators have consistently been technical experts deeply conversant with the dynamics of water resources distribution and management both in India and Pakistan, their Pakistani counterparts have not been domain experts with expert knowledge of the problems involved. This problem of the lack of expertise and competence has prevented us from analyzing crucial issue of national importance on our own terms and in our best interests.

In 1929, the U.S. economy was on the verge of collapse. During the Great Depression, when President Roosevelt engaged experts in 1932 to seek revival of the U.S. economy, David Lilienthal advised using seven contiguous states, rich in land and water, for better and coordinated agricultural activities. Lilienthal initiated the uphill task as the founding director of Tennessee Valley Authority and subsequently changed the American development landscape.

However, when he was called upon to act as an adviser in the case of India and Pakistan, he was charmed by Nehru, and recommended the two states to jointly control the Indus River Basin. Eventually, being the upper riparian state, India could get complete control of waters. Pakistan would fail to foresee the implications of this counsel.

### **Inequality of Water Rights**

Water rights under the IWT were not granted on an equal basis to India and Pakistan. India enjoys more rights than Pakistan does under the treaty. According to

3- See Appendix 1 for details.



the treaty, all the waters of the Eastern Rivers will be available for the unrestricted use of India but the same is not granted to Pakistan with respect to Western Rivers which should have been fully given to Pakistan. India can draw upon the waters of the Western Rivers for domestic use, non-consumptive use, limited agricultural use, run-of-the-river generation of hydro-electric power, and storage works. These flawed aspects call for a reconsideration of the treaty but Indians clearly do not favor this review.

### **IWT and the Health in Pakistan**

Moreover, according to the Article 4 of the IWT, Pakistan is bound to maintain in good order its portion of the above-mentioned four major drains with the capacities not less than the capacities as on the effective date of the treaty. The situation reflects the Indian approach of directing their drain water toward Pakistan while stopping the sweet surface water entering Pakistani territory, thus doing attrition to Pakistan's surface rivers. It is for this reason, amongst other things, that over 21 million people in Pakistan suffer from chronic diseases such as hepatitis.

### **Indian Disregard of the IWT**

Today, in the Indian-Occupied Jammu and Kashmir, India is working on 171 projects that are either being designed, implemented or operationalized, for the achievement of around 28,000 MW by 2020, of which, the Indian-Occupied Kashmir will receive less than 2,000 MW. These projects violate the provisions of the IWT in one way or the other.

The Annex-E of the IWT throws light on the amount of water to be stored for power, other uses, and during floods. There is some

storage on the Chenab Main and some on its tributaries. Chenab water is used five times more than what is allowed to the Indians in addition to the construction of dams ranging from small dams to those with the capacity of 1,200 MW.

Nehru had once said that dams were the temples of modern India, and today, the country has built nearly 4600 dams. It has constructed Baglihar 1 and 2 on the same pond. The Indian objectives are very clear; it will never disclose the actual amount of water being stored and sent to Pakistan. The irony of the situation is the unawareness of relevant organizations in Pakistan, such as WAPDA. The fact that water entering Kashmir is far less than water exiting it must be highlighted and protest must be registered at all appropriate bilateral, regional, and global forums.

The absence of this activism on the part of Pakistan is largely attributable to the absence of a unified commission in Pakistan. For instance, Baglihar 1 project was lost to weak decisions of the fifth IWT Commissioner from the Pakistani side. The ensuing problems of that negligence include additional water from the Indian side during crop seasons and the silting of Mangla and Tarbela Dams. The IWT binds Commissioners from both the countries to tour Indus Basin every five years and share data duly but there has been non-compliance from the Indian side.

### **Indian Designs on the Waters of the Indus and the Nefarious Anti-Gilgit-Baltistan Propaganda**

We have to be aware of the fact that India has set eyes on depriving us of the massive water resources of the River Indus. The Indus becomes a great river only after it



enters Pakistan.<sup>4</sup> It is for this reason that the inimical forces are trying to project Gilgit-Baltistan as part of Kashmir and misleadingly attempt to make it a part of the disputed territory between India and Pakistan. It is the biggest trick being played on us for the last twenty years. This insidious propaganda needs to be forcefully rejected and rebutted. We must protect our Northern Areas that have no link with Kashmir and the pending plebiscite. The people of the region are neither ethnically nor linguistically of Kashmiri origin. It is an independent autonomous area of Pakistan, and should be given a constitutional guarantee. This area is our lifeline and any reluctance or delay in protecting it may only add to already sizable difficulties. We must protect our lifeline at all costs.

### Way Forward

In the context of IWT, Pakistan needs to take serious proactive steps. Pakistan should seriously make efforts to validate that India has carried on a bacteriological war against Pakistan since 1960. Pakistan should consistently raise the issue of water theft and misappropriation by India in violation of IWT at all bilateral, regional, and international forums.

Pakistan should also explore the possibility of multilateral and third-party interventions to highlight and check Indian water aggression, given Indian intransigence toward bilateral negotiations. In this regard, Pakistan needs to devise a mechanism for correctly and timely calculating water flows from India to Pakistan.

New canals must also be built to bring the

waters of Indus, Jhelum, and Chenab to the areas previously irrigated by the Beas, Ravi, and Sutlej.

Kalabagh Dam is still the best option for resolving matters related to flood control and power generation in Pakistan.

The government needs to be mindful that the Akhori Dam project is the only backup to the Tarbela reservoir, and may face existential problems as Tarbela is an old dam. Tarbela's extension, though welcome, will not ensure greater energy provision or address water storage issues in the long run. The formation of a Commission for Indus Basin Strategic Analysis (CIBSA), proposed by an NGO in 1998, must be expedited for having a functional R&D organization in the water sector. Such a grand step would help regulate the domestic politics of water, bringing to the fore objective analyses and negating false propaganda. CIBSA can work together with other departments related to water and power.

Formation of another organization in coordination with CIBSA, the Pakistan Energy Planning and Execution Organization (PEPE), would be a vital instrument for involving best talent at the national level to be used for the improvement of water sector.

A detailed analysis of the IWT at the level of federal and provincial governments is critically mandatory for ensuring a pro-Pakistan implementation of the treaty. So far, the level of interest in this field is slim at these levels.

4- See Appendix 2.



Technical institutes and associations of water experts are required. We need to have domestically something like the International Commission on Irrigation and Drainage (ICID). They have more than 25000 technicians and experts working for them but none dares to talk against Indian water policies with respect to Pakistan. We need to build our strength domestically for the international projection of our just cause. We need a balance of professionals and bureaucrats in our handling of water issues. Only water experts, properly mandated by the state and government of Pakistan, can fix this problem for Pakistan.

In sum, a sustainable solution to nearly all the challenges that Pakistan faces today will be found in our endeavors to shape it into a country with considerable thinking power and intellectual strength. It must not be forgotten that knowledge is the basic ingredient of power in the modern world. We need to promote world-class education and training in all fields of learning, including the policy sciences. Pakistan must not step back from having its due share in the global development and should seriously focus

on creating an innovative policy paradigm in order to resolve challenges of the water sector.

### 2.3.2. Pakistan’s Inland Water Resources: Issues and Way Forward

**Dr. Muhammad Ashraf – Chairman, Pakistan Council of Research in Water Resources (PCRWR)**

The four key aspects of Pakistan’s inland water resources are: the existing water resources, the use of water in different sectors, the issues related to inland water, and a practical way forward.

#### Existing Water Resources of Pakistan

First, in so far as the existing water resources of Pakistan are concerned, the country has: 3 major storage reservoirs; 23 barrages, headworks and siphons; 45 main irrigation canals; live storage capacity of 15 million-acre feet (MAF); command area of 16.6 Mha; total geographic area of 80 Mha; cultivable land of 30 Mha; 12 Mha of rain-fed farming; and rainfall of less than 200mm to 1000mm.



Presentations: (From the left) Engineer Shamsul Mulk and Dr. Muhammad Ashraf (NUST Archive, 2019)



Pakistan's groundwater resources are the fourth largest after India, the U.S., and China, and supplement over 60 percent of the surface water supplies. Around 40 percent of cultivable land in Pakistan is solely dependent on rain water. This area has been neglected for the last 70 years. Nearly 93 percent drinking water comes from groundwater and almost 100 percent industrial water comes from groundwater. Almost 93 percent of our water goes to agriculture.

It is true that our irrigation system is one of the largest, but the fact remains that it is not one of the best managed. Water scarcity stands out as the most important issue. According to the research conducted by PCRWR, if population continues to grow at the present rate and continual stress on water resources remains unabated, Pakistan will touch the absolute water scarcity line by 2025.

We will only be left then with 500 cubic meters per person per day. We have already touched water scarcity line in 2004-2005. A few current initiatives to counter this issue include the establishment of a dam fund by the Supreme Court of Pakistan, and the approval of National Water Policy 2018.

## **Dominant Issues of Water-Sector**

### *Water Resource Development*

There has been inadequate development of water resources in the country. In the aftermath of recurring floods in 2010, 2011 and 2014, almost 90 MAF of water were lost. As per the World Bank, saving 1 MAF of water means saving USD 1 billion. The loss extends to massive devastating effects on agriculture, livestock, human life, and infrastructure. The root cause of this issue

is the inadequate water storage facility. The water received in wet years transforms into floods instead of being saved. Almost 0.2 MAF of water is lost per year to sedimentation in storage reservoirs. So far, 6 MAF have been lost. Pakistan has more than 18 MAF of water in unutilized potential.

Non-conventional water practices result in low water productivity. In the absence of sufficient surface water, reliance increases on groundwater, whose water table is depleting at more than 26 canal commands. In urban areas such as Lahore and Islamabad, water table is reducing at an annual rate of 1 meter per year while in Quetta it is around 6 meters per year. Quetta faces an additional challenge of the exhaustion of groundwater for general consumption to the extent of puncturing the hard rock for fossil water.

### *Water Resource Management and Governance*

Due to the lack of water regulatory framework, anyone in Pakistan can install tube wells of any size and can pump any amount of water. Rich farmers are taking the most advantage of such a state of affairs. They pump water and sell it to poor farmers who cannot dig a tube well for their own use. In order to reduce the gap between water supply and demand, almost 10 MAF of drainage affluent, and 6 MAF of waste water needs to be managed.

In terms of governance, ground and surface water provided to farmers, industries, and domestic consumers is almost free, at less than one dollar per acre per year. It is a complicated situation. In a report on water pricing submitted to the Lahore High Court Commission on Water, PCRWR had to conclude that corporations should not



be charged for water usage as the amount will eventually be collected by them from consumers. After ten years, groundwater will still deplete at an uneconomical level.

A model can be followed for establishing industries for maintaining a sustainable water level for a longer period; if the water level is 100 feet at the time of an industry's foundation in an area, it should stay the same in the next ten or fifteen years. The industry will either reduce the extraction or will have to increase charges in those areas. The water table will otherwise deplete in about fifteen years and the industry will shift elsewhere.

### *Financial Incentives*

Another important issue is the lack of crop earning. To serve foreign interests, we have started growing crops such as rice and sugarcane in areas which are not naturally suitable for them, and so are putting more pressure on groundwater for short-term profits. In the longer run, salination would render these areas unsuitable for decades for farming. A farmer's activities are driven by economics and he purely seeks out immediate benefit rather than sustainability. This is where the government needs to intervene and implement crop zoning to manage salination.

### *Waste Water*

The relevant authorities also need to be vigilant regarding the waste water present in our rivers.

### *Water Level*

In the Indus, water level has remained the

same, whereas in Chenab and Jhelum, the level is declining. This is either due to climate change or Indian involvement. Timely management of this matter would safeguard our water resources.

### **Work Done by PCRWR**

PCRWR is diligently working on its mandate "to conduct, organize, coordinate and promote research on all aspects of water, specifically irrigation, drainage, surface and groundwater management, groundwater recharge, watershed management, rain water harvesting, desertification control, water quality and overall environment."

Key steps include:

1. Determination of crop water requirement of all major crops in Punjab and Sindh through lysimetric studies, so that water can be divided accordingly.
2. Research on high efficiency irrigation system such as growing rice on beds. The myth that rice need standing water to grow has been debunked, as it can be grown now through sprinklers or other systems.
3. For the first time in history, areas in Punjab and Sindh have been mapped by PCRWR to mark bright and hot spots that will help in groundwater regulation. These areas include zones in the Upper Indus Basin – 4 Doabs in Thal, Bari, Rechna, and Chaj, and the Lower Indus Basin.<sup>5</sup>
4. Cost effective techniques of groundwater recharge and rain water harvesting have been introduced in Balochistan.

5- See Annex 3.



5. A classic example of technological advancement is that Thar and Cholistan are in the same desert but the latter is better off than the former regarding water. PCRWR and Cholistan Development Authority have built more than ten rain-water harvesting ponds at every fifteen miles, helping nomads in the area.
6. Satellite-based water resources management through Gravity Recovery and Climate Experiment (GRACE) and altimeter is being used to monitor groundwater.
7. Irrigation advisory service is in place to help farmers with the help of NASA and University of Washington. Around 20,000 farmers are facilitated per week.
8. The Asian Development Bank applauded technological advancement efforts at PCRWR and offered assistance in upscaling technology.
9. One of the most important projects is with the Indus River System Authority (IRSA) on updating the measurement system. Indus telemeters have been installed at four major canals in each province with the help of the Pakistan Army's Corps of Electrical and Mechanical Engineering (EME) Pakistan. It is a GSM-based technology that provides real-time data. Canals in Khyber Pakhtunkhwa province are also being instrumented, for which measurements are being conducted at a high level of accuracy.

### Way Forward

A constructive way forward demands the implementation of National Water Policy 2018 in letter and spirit. It is a consensus document signed by all the provinces.

It has provided a milestone regarding development, management, and governance of water, focused on the efficiency of dam construction (30 percent increase by 2025), water pricing, comprehensive regulatory framework, 100 percent metering of domestic water, and crop zoning. The issues have been identified, and recommendations and guidelines have been crafted in the form of the National Water Policy.

The issue here, like in other important national domains, is of implementation, about which William Blake aptly noted that “he who desires but acts not breeds pestilence.” We must, therefore, convert our words into tangible actions in order to reap benefits and avoid wastages.

An important question to be answered is how to transfer water from the Western Rivers to the drying Eastern Rivers that require appropriate systems. The Indian attempt of stopping the water flow of these rivers cannot be constrained, and at the same time these rivers cannot be left to dry out completely.

In order to deal with dry seasons and drought management, following are some crucial points to deliberate on: optimum reservoir operations; change in water quality and quantity that will inevitably impact food production, as food security is linked to water security; the development of climate-smart technologies; water supply and demand issues; and the development of crop zoning and cropping pattern.

The use of modern technologies such as drip and sprinkler irrigation and realistic water pricing policy will increase the efficiency of water use by producing “more crop per drop.” Other concrete steps may include the





effective reduction in the wastage of water, water theft, and non-revenue use of water together with the creation of crop ecological zones, and the establishment of provincial surface water and groundwater authorities. Moreover, systematic effort to study the complete water account system was not made in Pakistan. PCRQR is conducting it now.

In so far as groundwater in Balochistan is concerned, PCRWR has done 3 major things. It is trying to map groundwater there, particularly in the Pishin Basin as well as those locations at high risk of depletion. There, the focus is on finding bright and hot spots and then recharging sites.

Qanats or karizes have been a major free water resource for the people in the province. Due to technological advancement, these were abandoned. PCRWR submitted an application in the UNSECO for the karizes to be declared a cultural heritage. We succeeded in the effort and as a result there is pressure on the government of not wasting the cultural heritage. All these aqueducts are operational as a result.

PCRWR has introduced the concept of leaky dams in Balochistan. As is clear from its name, such a dam leaks water at a slow rate at the dam downstream at the rate it infiltrates in the groundwater. These dams are a better option than the delay action dams since recharge in these structures takes place at the downstream where the flowing water is free of silt with greater surface area for recharging the aquifer.

### 2.3.3. Views of the Discussants

**Engineer Shamsul Mulk – Member, Advisory Council, NIPS; Former Chairman WAPDA; Former Chief Minister, Khyber Paktunkhwa**

The main issue with Pakistan is its people, who are neither aware nor properly trained to deal with the problems of national development. Water-related problems, especially those related to the management of water resources, are in essence problems of human resource development. Our attitude to water like our attitude to so many other issues of development is neither rational nor indigenous and is mainly focused on advancing interests that do not reflect the prosperity of the country. Our inability to build Kalabagh Dam is one of the biggest national failures. It is a failure of our national collective will but unfortunately the issue has been disingenuously politicized to a point where it does not appear before our nation as a glaring failure. Naturally, in these circumstances, no sense of shame or embarrassment is felt.

We urgently need to develop the full potential of the Indus River System. The rapid and sustainable development of Pakistan turns on our ability to translate this into reality. This is the only way before Pakistan to get rid of borrowed development which is another guise for bad development. Pakistan should also advocate the joint Pak-Afghan development of the Kabul River System. Pakistan has the potential to work collaboratively with its neighbors as borne out by the successful development of the China-Pakistan Economic Corridor (CPEC).

We should pioneer and promote equitable



water sharing in the region as we have been able to sort out the water sharing issues internally. Kalabagh Dam should be similarly promoted on the basis of the massive benefits that will accrue to each province and the people of Pakistan.

**Professor Dr. Din Muhammad Kakar – Dean, Faculty of Earth and Environmental Sciences, University of Balochistan, Quetta**

Land subsidence has become a key global phenomenon that has affected big cities in both the developed and the developing worlds. It is attributed to both natural causes and human activities. Extensive groundwater extraction has been identified as a key cause of this phenomenon. Our research has found it to be the key reason behind the land subsidence in the Quetta valley.

Since the valley is largely dry so the groundwater serves as the key resource of domestic and agricultural consumption. Rural-urban migration, in particular the wave of such migration caused by the 1998-2004 drought, and the influx of refugees from the neighboring Afghanistan have increased the intensity of unplanned use of groundwater resources. It has been estimated that the central portion of the Quetta valley underwent a subsidence exceeding 1 meter during the decade of 2000s. The rate of subsidence continues to be 120mm per year accompanied by fissure development in several parts of the valley and groundwater depletion at an alarming rate of 1.5-5.0 meters in several parts of the city.

This may cause huge losses to currently existing urban infrastructure and may undermine the future development of the city. It may also lead to the mixing of fresh

water and sewerage leading to health hazards for the residents. Amongst other things, urgent measures to stop illegal drilling need to be put in place for the prevention of unplanned groundwater withdrawal. Quetta is a strategic area which needs to be taken care of. Otherwise, the untoward consequences will take a heavy toll on both the security and economic progress of Pakistan.

**Abdus Salam Khan – Former Secretary Irrigation and Power, Balochistan and Member Balochistan Public Service Commission**

The water crisis in Pakistan is primarily an issue related to the lack of good governance and efficient management. Before Pakistan undertakes a regional and global awareness campaign exposing Indian misappropriation of our waters, we need to do a lot of introspection and fix the national mismanagement of our water resources by utilizing these resources properly so that such a campaign would yield desirable results and so that it will not be dismissed by the world community as a diversionary tactic.

Highlighting the Indian hand in our water throes will be disregarded if we do not improve national water management concomitantly.

This is because the world can see that we are not utilizing our water resources properly. We cannot expect the world to be so dispassionate as to decry Indian water aggression while we continue to mismanage our own water.

Gwadar right now serves as a classic case of our lack of good governance and effective



Discussion Session: (From the left) Professor Dr. Din Muhammad Kakar , Engineer Suleman Najib Khan and Abdus Salam Khan (NUST Archive, 2019)

management. The water supply of a whole city, one of the critical nodes of CPEC, is reliant on water tankers.

Overall, Balochistan’s water potential was noted to be 12.2 MAF but about 3 MAF were utilized. In order to address this situation, we need to build small and medium dams in the province. Approval and implementation mechanisms for such projects also need to be fast-tracked. We also need to implement the National Water Policy in earnest.

We need an accurate water count to show the impact of Indian misappropriation of our waters. This count has to be done daily. We need to address the issue of water conveyance efficiency in addition to the issue of water use efficiency. Currently, the water conveyance efficiency of sweet water is only 64 percent. We need to undertake greater water recycling so that groundwater recharge can benefit directly, thus easing the

pressure on our aquifers.

We also need to undertake more effective management of groundwater to reduce its depletion. The only way is to manage recharge and control the demand. The issue is that we are not recharging in the areas where groundwater is depleting. Moreover, the existing water values have no supporting data. We need to have an accurate water accounting system. The water supply is linked to canal command area requiring farmers to use water even when they do not have any demand leading to a low water productivity. This demand-supply gap in canal command areas needs to be plugged.

**Ahmed Kamal – Chairman, Federal Flood Commission**

The construction of about four dams on the Chenab and Indus Rivers will be a game changer. The suggestion regarding the



Discussion Session: (From the left) Ashfaq Mahmood and Engineer Mushtaq Ahmad Gill  
(NUST Archive, 2019)

national think tank for deliberating upon water challenges, issues, and problems is a worthy one. In this regard, it is important to mention that the National Water Council (NWC), formed as per the National Water Policy, is already in place but so far it has held only one meeting in the October of 2018. The steering committee for monitoring the implementation of the National Water Policy by the NWC also exists, headed by the federal minister for water resources. Incidentally, I am the secretary of the steering committee. This committee needs to be staffed with at least 5 eminent water experts.

Meaningful events like this roundtable may become the platform for such merit-based appointments. We need not have just one but several think tanks and

organizations working on various aspects of water governance and management in the public domain and feeding their policy recommendations, research findings, and proposals into the water policy and governance bodies like the NWC and the steering committee to enable a process of rectification of inter-generational water-related issues of which transboundary water issues form one plank. There is a need to bridge the gap between such policy research deliberative bodies and policymaking bodies of the government. We also need reporters and columnists to write in newspapers locally and globally about transboundary issues to publicize these issues from the standpoint of Pakistan.



**Engineer Mushtaq Ahmad Gill – Chief Executive, South Asian Conservation Agriculture Network Services Pakistan (SACAN); Former DG On Farm Water Management**

The discussion has been very thought-provoking so far. One is surprised that the problems generated in the aftermath of the IWT still need to be resolved considering that the treaty went into effect almost 60 years ago. This says something about the glacial pace of change and reform in the country and in the region. If the great problems are not resolved when they are still small, as the ancient Chinese wisdom dictates, they continue to grow bigger becoming ever more difficult to handle. Excessive groundwater depletion has been the result because we could not manage our rivers properly on the one hand and because Indians continued to encroach on our waters ever so inexorably, on the other.

Like Quetta, Lahore is also suffering from extensive groundwater withdrawals which are not regulated so far. In fact, all large and medium-sized cities of Pakistan may be suffering from this trend. Without any regard for future generations and intergenerational justice, we are using water which rightfully should belong to Pakistanis of, say, 2045 or 2050. However, it is not a very practicable approach to keep repeating past mistakes. Rather, the focus needs to be on fixing those mistakes and avoiding further mistakes.

The enumeration of a few global success stories is in order to help us think creatively and pragmatically along the lines of finding solutions for our water problems. The first success story is the anti-desertification and the wonderful results achieved by the people of China in the Gobi Desert in Xinjiang, right at the mouth of the CPEC. China

has shifted most of its cotton plantation to the Gobi Desert region. We need to learn from the Chinese experience and apply them to our context with suitable adaptation. The second success story is the anti-desertification strategy in the Sinai Desert by Egypt. The third success story is from India, where in the Rajasthan region of the Thar Desert in India where thousands of water storage pounds have been built in contrast to Cholistan in Pakistan, which is also part of the Thar Desert, where there are only 200 water storage ponds.

There has been one-third reduction this year in our cotton yield. This is attributable to the impact of climate change. We need to understand the various problems in the domain of water and then go on to formulate distinct solutions for each region and each type of problem as part of an overall integrated approach. We need to develop a comprehensive roadmap and suggest it to government in a sustained manner.

**Dr. Zaigham Habib – Water and Climate Change Expert**

IWT needs to be revised as there are some gaps in it that can be addressed for Pakistan as the lower riparian state. Most international appreciations of IWT have tended to be biased in favor of India. IWT seemed to work as long as India was working on diverting the waters of the Eastern Rivers. Its problems have become pronounced as now India is encroaching on Pakistan's Western Rivers. One gap is that the IWT considered only river flows. It did not think about the population growth, future population use, and drinking water uses. Another gap is that the IWT did allow some agricultural use to the upper riparian state but it did not specify the quantity of this water use. It is causing



problems and shortages in base water flow for Pakistan.

We need to analyze right now the impact of these developments on Pakistan. These analyses have to take account of the demands of groundwater management, environmental flow, and household water management. The main water use system in Pakistan, i.e., agriculture, was designed for minimum water use or scarcity by design in the 1960s. With the passage of time, there has developed a very large gap in water use efficiency in different sectors and regions as new water use sectors and new water use patterns have come into being. For instance, the urban water use in Islamabad is much larger now than in a small city which the capital was supposed to be in the beginning. We have also inequitable water use at the sectoral and regional levels.

The issue of individual water users is a separate one. For them water is an input for their economic modeling. They try to optimize their use of water in the conditions of scarcity. There is also a large variation in water productivity at the farm level. Working

at the micro level, we have to undertake specific not general studies to understand and address these phenomena.

**Engineer Shamshad Gohar – Former General Manager, NESPAK**

While the state of water resources is serious in the country as a whole, the situation is dire in Balochistan in particular. Domestic, agricultural and industrial uses in Balochistan are heavily dependent on groundwater in the form of tube wells, qanats or karizes, dug wells, and springs. The provincial geography runs counter to the establishment of a centralized water infrastructure for water distribution and transportation. There have to be localized solutions each tailored to the locality and serving that it serves. Work on the improvement of the irrigation infrastructure and water resource management of the province is of critical importance. This is urgent given the fact that agriculture makes up about two-thirds of the provincial economy and engages around 60 percent of the provincial population. The agricultural economy of Balochistan, therefore, fails to function at its full potential. The rural areas



Discussion Session: (From the left) Muhammad Tahir Anwar, Engineer Abid Sheikh, Engineer Shamshad Gohar, Dr. Zaigham Habib and Rao Irshad Ali khan (NUST Archive, 2019)



of the province also suffer from serious water shortages. The aquifers in the province are approaching serious levels of depletion due to over-extraction as has been pointed out by Professor Kakar. This rampant practice needs to be checked immediately.

### **Rao Irshad Ali Khan – Member Punjab – Indus River System Authority**

On an average, Indus River has 90 MAF water, Jhelum has 22 MAF, and Chenab has 26 MAF, while 6 MAF comes from the Eastern Rivers. The average water availability from the six rivers is around 145 MAF. Moreover, these averages are from 1976 when the Tarbela Dam was commissioned. The maximum water supply was recorded in 1978 at 183 MAF and the minimum at 99 MAF in 2003-2004. Pakistan's maximum water storage capacity was 15.7 MAF in 1976 when Tarbela was commissioned. As of today, inclusive of the raising of Mangla Dam, it is 13.7 MAF which is 2 MAF less than that in 1976. Instead of moving ahead, we have in fact moved back.

The water supply from 1976 till date has been 99 MAF on average. During the early 1980s, it was 103 MAF. According to IRSA, Pakistan's present availability of water at different canal headworks is around 98 MAF with estimated losses per year of 48.29 MAF. Water going downstream unutilized and lost to the sea is 29 MAF every year. 1 MAF equals USD 1 billion. If we do the math, in the 43 years since 1976, we have lost around USD 1.247 trillion due to the lack of storage capacity.

It also needs to be clarified that the Indus River is 8 MAF when it enters Pakistan. It is 50 MAF at Diamer Basha. It is 60 MAF at Tarbela and it is 90 MAF at Kalabagh. There

are 4 possible sites for the construction of dams. The first one was at Skardu but as per WAPDA studies it was feasible in 1960s but has become unfeasible now due to the prohibitive cost of resettlement and infrastructure construction at that site. At Diamer-Bhasha, we have 50 MAF with storage of 6.4 MAF. Hopefully, the work will start there by early next year. At Tarbela, the Indus River is 60 MAF with the storage capacity of 6 MAF. From Tarbela to Kalabagh it is 30 MAF. We must have a reservoir at Kalabagh. We have 90 MAF of Indus River with only 6 MAF of storage. In contrast we have 22 MAF of Jhelum and we have Mangla Dam with storage of 7.3 MAF. This state of affairs is simply unacceptable. We must add a new reservoir between Tarbela and Kalabagh. We need both large and small dams so the argument in favor of only small dams is not tenable. Just like we need both food and water to survive, we need both small and large dams to survive as a nation.

For instance, take the case of India. Total average water availability in India is 750 MAF. India has the storage capacity of 250 MAF. Now, India's population is six times our population. 750 divided by 6 gives us 125 MAF. For 125 MAF, Indians have a reservoir capacity of 40 MAF. We need big dams so that we can save water going downstream.

**Brigadier (Retd) Fiaz Hussain Shah – Director General, National Institute of Disaster Management Pakistan**

### **The IWT and Contemporary Environmental Problems**

The IWT was signed to rationalize and regulate waters of the Indus River Basin (IRB) between Pakistan and India when



the world was not much familiar with the phenomenon of climate change. In the second half of the 20<sup>th</sup> century, there were immense technological and educational advancements in the fields of: hydrology; water resource management; trans-boundary watercourse management; conflict resolution; environment monitoring; and data acquisition, storage, sharing, and archiving techniques. Above all, the emergence of the new paradigm of climate change has added a new dimension to water availability.

Over the years, water quantity, with different variables like volume of water, timings and duration of its flow, frequency with varying intensity, and water quality, has immensely changed. Pressures such as population growth, urbanization, economic development, extreme climate events like drought and floods, and a decreased level of sub-surface water and aquifers have substantially altered the water demand and supply equation in Pakistan.

Consequently, water has become a source of tension between the two countries and has the latent potential to turn into a conflict if the existing knowledge and practice gaps in IWT are not timely managed.

## Possible Solutions

### *Climate Proofing*

One of the effective solutions is climate proofing the IWT by incorporating up-to-date knowledge, particularly of climate change and its alignment with the current set of international rules and water laws. Absence of these aspects in the IWT has a greater negative impact on Pakistan because it has only one river basin to draw waters from, as against India that has over

a dozen river basins. The thought process for a way forward shall prescribe proposed arrangement for climate proofing of IWT with the objective to induct current climate change knowledge and promote harmony in rationalizing water resource management.

### *Trans-boundary Dialogue and Peacebuilding*

The process toward the resolution of problems shall also foster trans-boundary dialogue and cooperation in the Indus River Basin for effective implementation of the IWT. It shall have pronounced impact in the realm of peace-building through the incorporation of climate change phenomena in trans-boundary water resource management.

Strategic objectives of this line of thought and action will be aimed at projecting climate change abatement, the protection of international waters, and the prevention of environmental degradation.

The anticipated results of this way of thinking would have various physical, socioeconomic, and environmental dimensions to mitigate the impact of climate change and minimize the consequences of extreme events like floods and droughts.

It would also better help in determining the water-food-energy nexus and the health and livelihood interests of communities and how those would be protected if the climate proofing of the IWT is done.

### *Role of Ministries and International Organizations*

The Government of Pakistan should initiate the process through the Ministries





of Climate Change and Water and Power to effect amendment through additional protocols along with the IWT by activating formal diplomatic channels for holding negotiations with the Indian government and the World Bank, the guarantor of the IWT, for this purpose.

**Muhammad Tahir Anwar – Director General, Federal Water Management Cell, Ministry of National Food Security and Research**

It is of the essence to determine the appropriate levels at which different problems related to water need to be addressed. This is the question of allocating and apportioning responsibilities for these problems between the federal government and various provincial governments. 60 years on from the signing of the IWT, we are still at the stage of discussion. While different organs of the government have done good work, yet there has been scant effort so far to integrate efforts and build scale in the domain of water resource development and management.

We have the issue of sweet water percolating in groundwater. More energy is then required to pump it to utilize it. The issue of scores of polluted water sources across the country also needs attention.

No federal government is usually interested in owning the agricultural sector because it is a provincial subject. The present government is, however, trying to focus on water, build reservoirs, and thus to improve water efficiency.

More research and awareness is also required at the level of universities and think tanks.

**Engineer Abid Sheikh – Chief Engineer Hydro Electric Planning, WAPDA**

There is a need to focus on priority on the reservoir projects. These reservoirs will improve the water availability for Rabi crops. There are several water storage projects on which work is at different stages. In addition to Kalabagh, Diamer-Bhasha, Mohmand, and Akhori, 9 new projects are underway.

Chiniot Dam project has a gross water storage capacity of 0.90 MAF and power generation capacity of 80 MW. Shayok Dam Multipurpose project, on Shayok River about 3 km upstream of Khaplu Town, in G-B, has a gross storage capacity of 8.5 MAF and power generation capacity of 640 MW. Diamer-Bhasha and Dasu together have a power generation capacity of 8,820 MW.

On the Indus, five storage sites on Shayok, Skardu, Bhasha, Tarbela, and Kalabagh can help harness the potential of the mighty river. Chenab is a wild river. The frequency of floods in the river is very high. Four possible storage sites at Chiniot, Wazirabad, Midh Ranjha and Shakargarh have been identified. These storage sites are required for flood control and also the provision of water to Lahore.

The Sindh Barrage Project has been identified and formally approved to address major water issues in downstream Kotri Barrage like sea intrusion, delta land erosion, wetland habitats and mangroves loss, climate change impact, and fresh water non-availability for irrigation and domestic consumption.

In short, various projects are underway whose successful construction and operationalization will allow us to deal with



our water problems. We can afford to be cautiously optimistic but need to keep alert and focused on the completion of all these projects within their slated timelines.

**Dr. Muhammad Irfan Khan – Professor, Environmental Sciences, International Islamic University, Islamabad**

There is a need to broaden the national security agenda to include environmental security. Environmental security should be considered in terms of water, food, and energy. Similarly, there is a need to include environmental diplomacy to the national foreign policy agenda. Unless these two agendas are broadened as suggested, we will not be able to handle the impact of climate change effectively to ensure inter-state and domestic peace.

**Dr. Javed Iqbal – Professor, Institute of Geographical Information System (IGIS), School of Civil and Environmental Engineering (SCEE), NUST**

Glaciers in the Upper Indus Basin must be mapped as they are the source of around 60 to 70 percent of water in Pakistan's rivers. The

construction of new dams like the Diamer-Bhasha Dam, Dasu Dam, and the Kalabagh Dam is an urgent national task that needs to be undertaken without further delay. Increasing population, rapid urbanization leading to increased water requirement, and the impact of climate change demand that the building of new dams should be a priority.

Measures for increasing national water productivity need to be introduced and institutionalized helping stave off the pressures arising from the increased water demand till the new dams become operational.

Moreover, in line with the international legal framework and relevant conventions and rules for addressing transboundary issues, Pakistan needs to put in practice world-class water diplomacy with both India and Afghanistan so that the practices of these states do not lead to any prejudice to the equitable utilization of shared water resources. Amongst other things, if positive thinking prevails in India and Afghanistan, effective joint integrated flood management



Discussion Session: (From the left) Helga Ahmad, Professor Dr. Din Muhammad Kakar, Engineer Suleman Najib Khan and Abdus Salam Khan Gill (NUST Archive, 2019)



could also be put in place together with the joint management of transboundary groundwater resources.

### Helga Ahmad – Environmentalist

As a grassroots-level worker in the field of environment, I have reached the conclusion that Pakistan needs to maintain an inclusive focus on all dimensions of water security. Watersheds, in this respect, must be a priority element – efforts, however, appear scarce so far in this regard. Furthermore, the global climate change is largely blamed for the melting of glaciers.

Hundreds of thousands of ruminants are depleting the rangelands and glaciers are sliding as the slopes along their courses are warming up, including: the massive deforestation in the northern areas; wrong agricultural practices which also require removal of indigenous plants; and the diversion of glacier water to irrigate new crops, while ignoring the geomorphology of the soil.

Some other examples of negligence are:

- i. The process of cracks above Attabad was known since 2002 and no steps were undertaken to proactively solve the problem.
- ii. The National Disaster Management Authority (NDMA) initiated a study in the northern area of Nagar in 2014, as land was sinking, cracking and sliding. The reason was then identified as wrong land management.
- iii. The International Fund for Agricultural Development (IFAD) is developing 50,000 acres of land without studying the geology of the identified sites.

- iv. Khyber Pakhtunkhwa has planted thousands of Eucalyptuses along Kabul River. One tree is known to consume around 50 liters of water a day.

In the above context, numerous issues await solutions under the aegis of good governance and technical management by experts.

### Dr. Muhammad Irfan Ashraf – Assistant Professor (Forestry), Arid Agriculture University, Rawalpindi

Food security is at the mercy of water availability, which is critically influenced by forests. These forests are a source of about 75 percent of the world's accessible freshwater for agricultural, domestic, industrial and environmental uses, with 90 percent of the world's cities relying on forested watersheds for their water supply. The quantity and quality of fresh water is critically dependent on the management of forested watersheds. Proper forest management of watershed areas contributes to cloud and rain formation, reduce erosion, and recharge groundwater.

According to the Food and Agriculture Organization of the United Nations, globally, watersheds have experienced 40 percent tree cover loss, resulting in increased risk to water stress, erosion, and forest fires. The management of forests for water is, therefore, increasingly important.

In the past, WAPADA has been focusing on managing Tarbela and Mangla watersheds but probably has discontinued now. An independent body consisting of professional foresters should be established for the management of afforestation as well as the conservation of existing forests in watershed areas.



### 2.3.4. Closing Remarks

**Dr. Ashfaq Hasan Khan – Principal and Dean, School of Social Sciences & Humanities (S3H), NUST; Director General NIPS**

The roundtable discussion was especially productive. A broad range was covered with many useful recommendations. Issues related to water resources development, management, and governance were discussed. From pitfalls in our water diplomacy to problems in the management of inland water resources were discussed. The problems of urban and rural water use were touched upon. Agricultural and industrial utilization of water was also discussed. Indeed from the standpoint of agriculture in the context of water scarcity, it is a challenge for Pakistan to continue growing rice and sugarcane in the traditional manner. It was about time that serious and groundbreaking research

work was undertaken on the economics of water use and consumption in urban and rural settings as well in the agricultural and industrial contexts. The impact of climate change is seriously affecting our agricultural output and the quality of our urbanization. We also need to ponder on the effects of the encroachment of sugarcane into our cotton belt.

The second phase of CPEC has already gotten underway. One of the critical components of this second phase is agriculture. We need to learn from the Chinese experience in this regard so that we can also create national success stories in agriculture. The long-term sustainable development of Pakistan is indeed linked to the proper utilization, development, and management of our water resources. Therefore, it needs to be addressed through a comprehensive and integrated approach.



Group Photograph (NUST Archive, 2019)



### 3. Key Recommendations of the Roundtable

Following are the key recommendations that emerged from the roundtable discussion:

1. The massive potential of the Indus River System needs to be harnessed through the construction of a series of large, medium and small dams so as to increase the national water storage capacity. In this regard, prevalent misperceptions and reservation of various stakeholders with respect to the Kalabagh Dam should be addressed and removed on priority basis.
2. The flawed nature of the IWT needs to be understood by the policymakers and decision-makers of Pakistan coupled with an international campaign to highlight Indian misappropriation of Pakistan's waters and blatant Indian water aggression against Pakistan. In this regard, a detailed analysis of the pitfalls of the IWT is required at federal and provincial levels. Efforts should be made to amend the IWT in line with the changed demographic, environmental, and political realities. This revision should be undertaken in a manner that protects the rights of Pakistan as the lower riparian state.
3. The dumping of untreated water by India in the four drains that flow into Pakistan should be publicized at all the relevant bilateral, regional, and international forums as it is a violation of the IWT that binds India to treat the waste water before releasing it downstream.
4. The IWT should be climate-proofed through the incorporation of up-to-date knowledge of climate change and its alignment with the current set of international rules and water laws. In this regard, the role of the ministries of Climate Change and Water and Power should be leveraged to effect required amendments through additional protocols in IWT through the activation of formal diplomatic channels for initiating negotiations with the Indian government and the World Bank.
5. New strategic organizations like the proposed Commission for Indus Basin Strategic Analysis (CIBSA) and Pakistan Energy Planning and Execution Organization (PEPE) should be set up for integrated policymaking and implementation in the domain of water resources development and management.
6. The nefarious attempts to deprive Pakistan of the massive resources of the Indus River through projecting Gilgit-Baltistan as part of the disputed territory of Kashmir need to be forestalled legally and politically. Misperceptions existing within Pakistan should also be allayed.
7. Technical institutes and associations of water experts are required in the country to create a critical mass of water experts and a culture of extensive research into different facets of the problems related to water. A corps of legal experts fully conversant with all the dimensions of international law, rules, and conventions, including those related transboundary water resource, should be promoted and based in different organizations and institutions across the country.



8. The earnest implementation of the National Water Policy 2018 is required. The capacity of the National Water Council and the steering committee for the implementation of the National Water Policy 2018 should also be enhanced. The steering committee should be staffed with renowned and credible water experts.
9. National water reservoirs should be made to operate optimally. Moreover, the existing arrangement of channeling water from the Western Rivers to the drying Eastern Rivers needs to be revisited to take account of the increased water needs of the regions which were once irrigated by the Eastern Rivers. Moreover, water has to be transferred from wet seasons to dry seasons.
10. Climate-smart technologies need to be developed in the area of agriculture.
11. Water supply and demand issues have to be addressed in line with the existing realities of the various geographical regions and various sectors of the economy. A realistic water pricing policy should be introduced to curb non-revenue water use. Water use efficiency should be introduced by producing “more crop per drop.” Water theft needs to be curbed in a strict manner.
12. The rational development of crop zoning has to be undertaken and cropping pattern must fall in line with the availability of water in the given region or area. Demand-supply gap in the canal command areas needs to be bridged to check low water productivity.
13. Groundwater should be recharged in areas where it is depleting. Groundwater depletion through unregulated extensive withdrawals needs to be checked. All industries reliant on groundwater withdrawal, especially bottling companies, should be legally bound to recharge the depletion caused by the withdrawal so that the water level at which the water was originally drawn does not go down.
14. Greater water recycling needs to be undertaken to ease pressure on groundwater. Besides, as a matter of policy, rainwater harvesting and storage should be made mandatory at household, village, town, and city levels. It should be made a part of town planning and rural development.
15. Islamabad’s groundwater depletion should also be addressed on emergency basis. The CDA bylaw on water harvesting should be strictly implemented in Islamabad.
16. Balochistan should be the center of groundwater strategies as it is almost wholly dependent on these resources. In this regard, the implications of extensive groundwater withdrawals for land subsidence, as evidenced in the Quetta Valley, need to be understood and incorporated into the groundwater management in other regions of the country as this problem is directly linked to urban development and the integrity of rural-urban infrastructure. Irrigation in Balochistan should also utilize treated waste water for easing the pressure on groundwater resources. The establishment of provincial surface water and groundwater authorities should also be considered.



17. Awareness-raising campaigns, especially targeting the youth, should be launched nation-wide. Moreover, a national campaign should be launched that brings together universities, relevant ministries, civil society, and religious scholars for emphasizing and inculcating water conservation. This campaign should utilize all relevant media for this purpose.
18. Water conveyance efficiency should be enhanced in addition to water use efficiency.
19. Monitoring systems need to be modernized to undertake accurate water count, preferably daily, so that existing water values should be backed by real-time supporting data, thereby allaying provincial misperceptions.
20. The gap between water-based policy research and water-based policy making needs to be bridged more effectively.
21. Pakistan should learn from the global anti-desertification success stories of China, Egypt, and India for creating its own domestic success story in anti-desertification.
22. Transboundary dialogue and cooperation in the Indus River Basin should be promoted between India and Pakistan in the spirit of addressing mutual differences by peaceful means despite Indian water aggression.
23. The national security mosaic should be broadened to include environmental security in terms of water security, food security, and energy security. Similarly, the foreign policy agenda should be broadened to include environmental diplomacy.
24. Efforts at joint flood management should be put in place with both Afghanistan and India as part of the greater regional peace and development agenda.
25. The management of forests for water availability should be prioritized in the government's policy thinking. Watershed management should be a priority area of water management and governance. An independent body consisting of professional foresters should be established for the management of afforestation and the conservation of existing forests in watershed areas.
26. The concept of virtual water trade should be understood by the government for national trade diversification strategies to be sustainable.
27. Agricultural cooperation between China and Pakistan in the second phase of CPEC should be prioritized for the learning of successful Chinese strategies for water resources development and management, and achieving agricultural breakthroughs in Pakistan.



# APPENDICES

## APPENDIX 1

### IWT 1960 WAS AN ILLUSION, WAKE UP PAKISTAN <sup>6</sup>

The IWT signed on 19 September, 1960 was supposed to mean “Indus Waters Treaty” a path to peaceful cooperation, good neighborliness & progress. Tragically we observe that Indian Water Aggression since 1947 has continued with undiminished intensity. They only toned down their rhetoric after the Treaty but never really abandoned their objective; to steal the waters of Indus basin till the state of Pakistan as existing today would collapse economically. India doesn’t respect any International Water Law or the rights of a lower riparian. She has virtually stolen the waters of the Chenab. She violates the IWT 1960 on all three Western rivers flowing through IHK. For the Indians, IWT only meant; India Wants Time. Yes, the trusting and simple people of Pakistan actually trusted them. Now, Mr. Narendra Modi has gone 100% back to the immoral and inhuman hydro-politics of 1948. It may not be forgotten that the Pakistani people lost millions of their brethren during the mass migration in the partition of British India. Pakistan became independent on 14th August 1947 but alas only in name within the Indian mindset. The imperial ruler had ensured that the three Eastern tributaries of the Indus Basin (River Ravi, River Sutlej & River Beas) flowing through Indian Punjab are controlled by the

upper riparian. Madhupur Headworks on the Ravi River and Ferozpur Headworks on the Sutlej & Beas combined flow were delivered to India through the blatant “Radcliffe Award” that partitioned British India. A perfectly diabolical and cynical India agreed to send a negotiation team in 1952 on the invitation of President Truman. The World Bank was tasked to be the ‘facilitator’ and the venue was Washington D.C. the next eight years saw negotiations and talks between India and Pakistan delegates. The Indian side was led by Mr. N.D. Gulhati, a brilliant hydro-engineer while the Pakistan side was led by an eminent but non-technical bureaucrat Mr. G Mueenuddin. Whatever the draft of the Treaty conceded in the main text comprising of 12 articles, was cleverly clouded and neutralized in the 8 Annexures to these Articles and complex Appendices to these Annexures. What the right hand conceded the Indians took back via the left hand using these Annexures. The treaty draft was being negotiated by an upper riparian state with a lower riparian state over waters of the sole river basin of the lower riparian. Territorial reality gave a massive advantage to India. They got 100% waters of the three eastern rivers.

An eminent Engineer Sardar Mohammad Tariq, former Member water of WAPDA, writes that by allocating 75% of the Indus Basin Waters to Pakistan which had 90% of the irrigated land there was a blatant violation of the principle of “appreciable harm”. A defining statue of International

6- Available from <https://www.wrdc.com.pk/IWASeries/IWA14>.





Law Commission. Let us remember that India was allowed to take the entire flow of the three eastern rivers viz Ravi, Sutlej and Beas. These were compelling reasons for the World Bank's President, Mr. W.A.B. Illiff who was in Karachi on the eve of the Treaty signing (19 Sep, 1960) to advise President F.M. Ayub Khan that Pakistan may not sign, if there were other options available i.e to end Indian military occupation of IJK! The 1965 war was a little late & inconclusive. Water and its vitally strategic importance for Pakistan is not understood & appreciated by our nation in all its economic dimensions. The nation is flying blind with respect to its water endowment. Let us seek the truth.

**Indian Water Aggression (IWA).** India's P.M. Pandit Jawaharlal Nehru said in 1950 "dams are the temples of modern India". He may not have ordered these temples to be built on Pakistan waters however as a founding father of independent India and with military annexation of J&K he did create conditions for her hydro aggression. Our nation underestimated the reach of Pakistan's fifth column. Surely the Indians influenced a section of our bureaucracy & regional politicians through their clearly identified agents. This ongoing tragedy cannot be reversed without a gigantic step. Firstly the **realization** that we have as a nation been the victim of a massive conspiracy with respect to our hydro endowment and in tandem the attrition of all our hydro based economic activities. The military occupation of Jammu & Kashmir on the eve of partition was the start of the Indian Water Aggression in connivance & with full support of the imperial power. In brief the IWA strategy was not fully comprehended by our intelligentsia and the issue was & remains clouded by religious over tones. Mr. Mohammad Ali Jinnah's warning was

not understood just as the nation ignored his caution note on the activities of our fifth column. Secondly the **periodic stage wise** progress of the IWA strategy. The period 1947-1960 was consolidation of the military occupation of Jammu & Kashmir as well as the implementation of the inhuman and unprecedented policy of taking the entire flow of the three Punjab Rivers (Ravi, Beas & Sutlej) also called the Eastern Rivers. The Indus Water Treaty signed on 19 Sep 1960 was a terrible tragedy for West Pakistan being acceptable only under great stress. Of the 33MAF average annual flow the historic share of West Pakistan was 27MAF which reduced to about 26MAF at the time of treaty. Effectively Pakistan had lost close to 20% of its surface flows till eternity. Bureaucrat Mr. G. Mueenuddin, Pakistan's head of the Indus Water Delegation to Washington DC was no match for India's hydro expert Mr. N.D. Gulhati. In the Treaty draft India also laid the basis for the subsequent controversies around semantics & interpretation. The real meaning of 'let flow', 'non-consumptive', and 'the then' phrases in the Treaty were all Indian manipulations that they later misuse.

The Indian delegation at Bangalore during the roundtable of February, 2014 also tried to deny that there is serious climate change and global warming leading to glacier retreat and consequential additional flows in the Indus Basin. Dr. Shakil Ramshoo of the Srinagar University was constantly trying to convince our delegates that global warming is a myth. It was therefore, nature's revenge that in late summer 2014 Srinagar was severely flooded. How could India deny that under their NRL they are constructing 47, 000 km of canals linking their 25 major & 103 sub-basins to cater for the greater flows due to global warming (& the logical glacier retreat). It may be understood that



India has also decided to construct a dam on the Kabul River and is willing to finance the Afghans. Construction of the dam on the Kabul River is planned within the next few years. The reservoir thus created would be far larger than the needs of the surrounding agriculture in Afghanistan.

The underground aquifers have clearly emerged as the next main target for the Indian Water Aggression. I had prepared a case for environmental flows in the Ravi and Sutlej Rivers to be taken up at Bangalore during my second encounter in India. The roundtable under track-II was held in Bangalore on 16 & 17 February, 2014. Instead, India's main thrust was to justify pumping of underground water far beyond the share of the western rivers/ waters permitted for Jammu & Kashmir's local population. It was a diabolical and cruel statement to argue that only the rivers were divided in 1960. In the words of Ramaswamy Iyer, the leader of the Indian delegation, "Mr. Khan note clearly, there were two partitions of India; in 1947 the land was divided and in 1960 the rivers were divided"! Then I reacted with the words, "this is non-sense Ramaswamy Sahib. The Ground Water (GW) is a part of the river valley. The treaty is called the Indus Water Treaty and not Indus Rivers Treaty. Therefore, no attempt should be made to take our ground water beyond the limits given for all waters in the Indus Waters Treaty 1960". He retorted that India has still to build its permanent storages to which I responded that at any given time India is already stopping more waters than is permissible under the Treaty. Since flow data of Western rivers from India is unreliable (and never received within the time frame of the IWT 1960) so we Pakistani's are reasonably convinced that India has found ways & means to siphon it

to Northern India. Similarly the 28,000 MW India will generate from +171 projects (run of river HPP or reservoirs) on these western rivers is at least ten (10) times the needs of the local population of IHK.

Now, the following steps are urgently needed to be taken by our nation:

i. We have literally lost most of the waters of the Chenab River, as a result of post Treaty Indian Water Aggression. Pakistan has now to struggle harder to save the flows of the other Western rivers; Indus Main and the Jehlum. The nation has to wake up and take note of this life threatening situation. India will stoop to any inhuman level to damage Pakistan's economy while profiting from our waters. All regional lobbies working against the Indus Cascade are to be neutralized; academically & scientifically. We have not built a large dam since Tarbela was effectively completed in 1974. Indians built +4,600 dams including Bhakra on the Sutlej, a 225m straight gravity dam, the highest in the world, as well as the controversial Narmada.

ii. In 1960, the Science of Ecology was not officially recognized by the UNO. It was after the Helsinki Treaty of 1962 that Ecology and Environmental Sciences received universal sanction. That is the compelling reason for demanding environmental flows in the Ravi and Sutlej at the Bangalore roundtable. The sharp retort by Ramaswamy Iyer is quoted in the preceding paragraphs. In brief, the Pakistani nation has to take note of this ominous Indian position and manipulations of the IWT 1960 text. The people of Pakistan are suffering horrendous health issues due to the



willful pollution of its waters. In fact, by taking away the total flows of the river Ravi, Sutlej & Beas, India has inflicted an ecological and bacteriological war on our people. Our over-reliance on GW is a terrible ongoing tragedy. In addition to heavy metals and arsenic the aquifers has suffered irreversible bacteriological contamination. Compounding our failure to treat & re-cycle wastewater (agriculture run-off, industrial effluents & municipal sewage). Presently there are +20 million Pakistani suffering from hepatitis and resultant cancers. The world has to be made aware of this great calamity. First we have to understand it. Falling GW levels is proof that our aquifers are not a renewable resource. They need adequate recharge. Let our anti dam lobbies be made to understand this and made to stop their mischief.

iii. The situation of the environment is equally serious. By shutting off the three Eastern Rivers, and controlling the flows of the three Western Rivers flowing through IHK, India creates drought like conditions during sowing seasons. The committed +55000 cusecs minimum flow during the entire flood season (21 June to 31 Aug) at Marala, where Chenab enters Pakistan, is not been seen since +20 years. During the monsoon/flood season we witness that India can suddenly induce serious flooding in the agricultural belts of Punjab and Sindh. This proves that she has enormous storage in IHK, UP and Eastern Punjab. Therefore Pakistan has to make the world realize that India also carries out environmental degradation of the Pakistani Nation's economy. This is as critical to realize as the ongoing ecological and bacterial war being waged by India. The economic degradation

due to Indian Water Aggression is now manifesting.

iv. Construction of large dam was made controversial after the Bangladesh war through India's clearly identified lobbyists working in Pakistan (as anti-dam pressure groups). They take a different position in the North West where the anti-partition Bacha Khan group of Wali Bagh increased their activities against building of the critical Kala Bagh Dam/ Kala Bagh Dam project (KBD/KDP) by propagating dangers of flooding of Nowshera town due to the proposed down-stream KBD/KDP. This group is unable to prove since 45 years how a down-stream dam with a maximum conservation level of the reservoir at 915 feet (above sea level) could create water logging or flooding in areas of KP province which are much higher than 915 feet asl? Analysis of floods 2010 is available. We know Bacha Khan is remembered by his followers and Indians as the "Frontier Gandhi". To this day his party-men call themselves "Congressites" associating them with the Congress Party of India that achieved independence in 1947.

v. In contrast, the Sindh anti-dam lobby in the south is a group of feudal (Waderas) who lay claim to all waters of the Indus Basin. They are happy to practice flood irrigation (sailaba) around the banks of the Indus River. They are oblivious of water waste and Sindh's agriculture generally uses about five times per acre as compared to agriculture in Pakistan Punjab. They don't realize that flood irrigation (sailaba) is highly wasteful and leads to water logging. This neurosis in Sindh is politically driven by the Wadera Group. These pseudo



political lobbies need to be neutralized by a truthful and extensive campaign within the Sindhi masses. According to Dr. Hon. Shams ul Mulk, these lobbies inside Pakistan are following an “Indian agenda”. Let our anti dam lobbies be made to understand this and made to stop their mischief.

vi. KBD/KDP is vital for flood control in the Indus Basin in central Punjab, Sindh & Balochistan. Floods in rivers Kabul, Sawat, Soan & Kohat Koi can only be controlled by the KBD/KDP reservoir. KBD/KDP is the only point on the Indus able to provide a gravity flow canal for KP. DBD can never be a replacement for KBD/KDP. In fact DBD must be made into a lower & safer structure. Instead of a dam going to 3,900 ft asl (river bed is at 3,000 ft asl) it must have a crest level of about 3,660 ft asl. The upstream Raikot HPP (1800 MW) becomes possible when DBD's height is reduced in line with the 1987 study. Its cost reduces to about half. The time to build it also reduces automatically. Remember all basic construction materials including sand have to be transported to site. Equally important lower height will allow a stronger CFRD arch dam instead of the proposed RCC light structure with a PVC membrane, for seepage control.

vii. Pakistani nation has to negate the repeated declaration by India (consented inadvertently by several of our leaders) that Pakistan's Northern areas, Gilgit & Baltistan, are a part of greater Kashmir. She does this to block or delay any infrastructure work including major hydro projects on the Indus Main. She cleverly misuses the policy of the World Bank which prohibits multi-lateral financing for infrastructure projects

in the so called “Greater Kashmir” disputed region. Pakistan must clear this misconception and travesty; convince the multi-laterals that its Northern Areas were indeed administered by Srinagar during the reign of Maharaja Ranjit Singh. However the Northern areas are inhabited by the Balti-civilization having no linguistic or ethnic similarity with the Kashmiri people. Thank you Maj Brown for having kicked out Brig Ganzara Singh from the Northern Areas in 1947 when he claimed it on behalf of the Raja of Kashmir. The latest claim of RSS Chief Mohan Bhagwat on AJK, Gilgit & Baltistan be noted.

## Conclusion:

A 70 years history of Indian Water Aggression is genocide in slow motion. Let us unite in thoughts & action to salvage the remaining waters of the Indus Basin for the common good of our children and coming generations. Let one organization within the country speak about Kashmir and the Indus Basin endowment. This national organization must be able to again map the seriously sick GW resource (it was last done in 1980). It must provide us practical solutions for its recharge. It must breathe life into the PCRWR. Strengthen the vital PCIW organization (and WAPDA as well). It must map our hydrology in real time. It must be 100% trusted by all patriots in Pakistan. Let us call it CIBSA (Commission for Indus Basin Strategic Analysis). Our response to the ICID & ICIW.

Our economy in 40 years has taken a hit of nearly a trillion USD equivalents due to these anti dam lobbies. The losses are

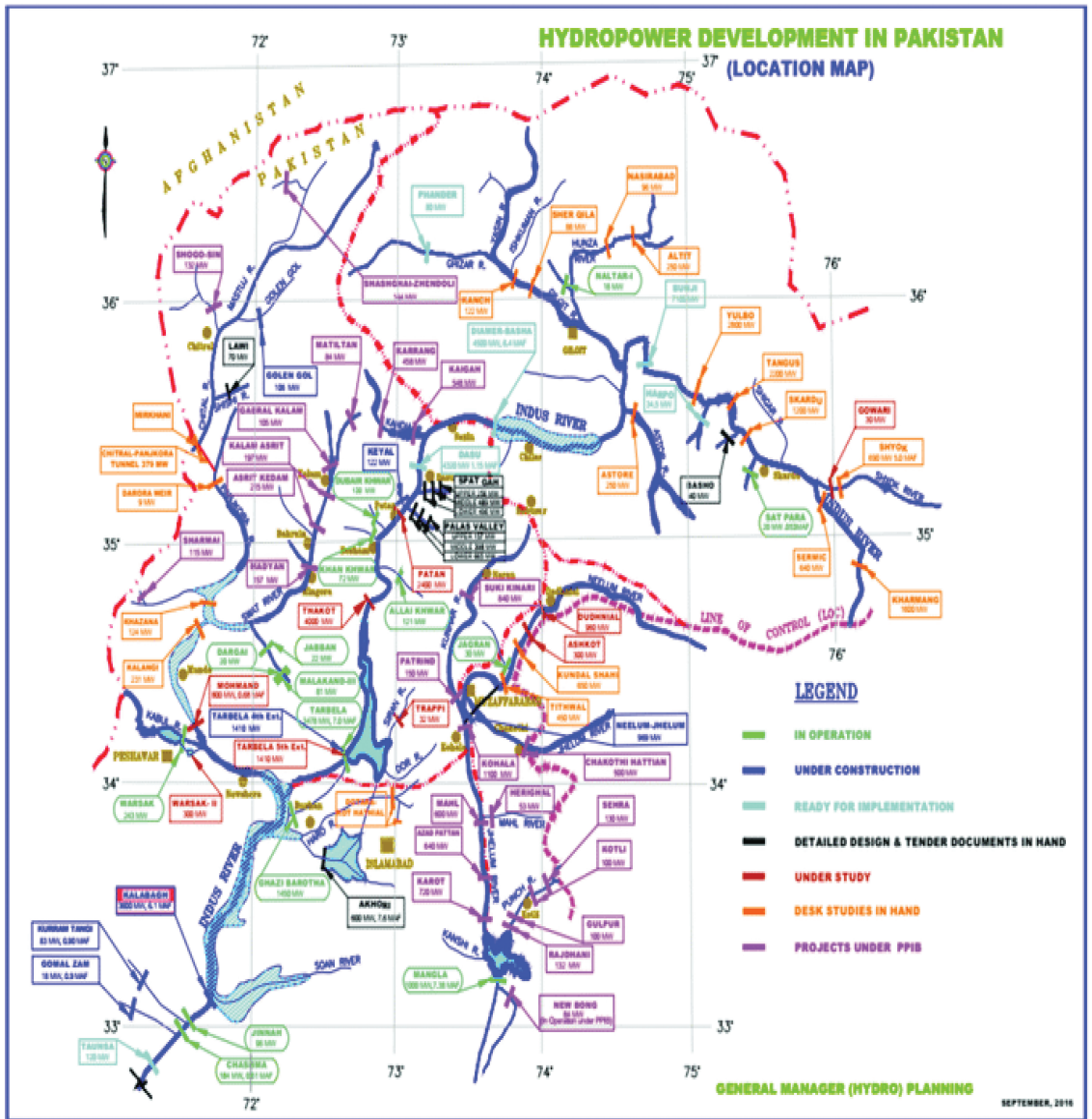


snowballing and the hemorrhage has to be stopped asap. No more illusions. Let us rise to the challenge belatedly and build the Indus Cascade with its 29,870 MW hydro power capacity translating into 126,000 GWh of electrical energy (which is more than the total electrical energy generated in Pakistan during 2015). A program of about 25 years to keep our nation moving ahead with low cost hydro energy, additional irrigation water and more portable water.

**Suleman Najib Khan**

IWA-14 (Water Resource Development  
 Council  
 (WRDC) Publication)  
 Dated: 13 October 2016 (R2)

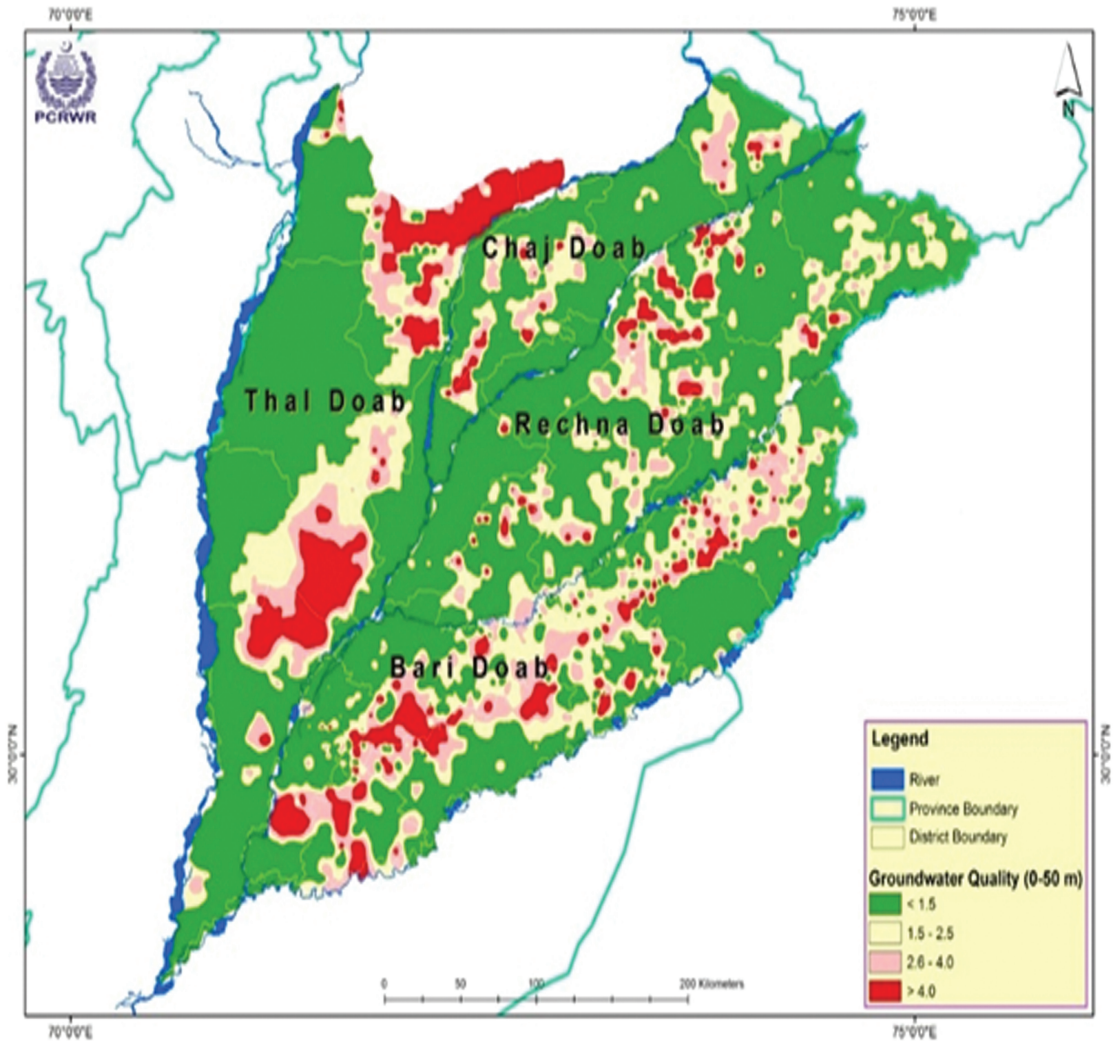
## APPENDIX 2 THE INDUS MAIN AND GILGIT-BALTISTAN<sup>7</sup>



7- Source: The Presentation on the Impact of the Indus Waters Treaty (IWT) on Pakistan by Engineer Suleman Najib Khan.

### APPENDIX 3

## MAP OF GROUNDWATER ZONES IN THE UPPER INDUS BASIN'S 4 DOABS<sup>8</sup>



8- Source: Presentation by Chairman PCRWR, Dr Muhammad Ashraf on Pakistan's Inland Water Resources: Issues and the Way Forward.



## APPENDIX 4 LIST OF PARTICIPANTS

Sr. No.	Name	Designation/ Institution
1.	Lieutenant General Naweed Zaman (Retd.)	Rector NUST and Patron NIPS
2.	Dr Ashfaque Hasan Khan	Principal & Dean, S3H, NUST & DG NIPS
3.	Engineer Shamsul Mulk	Member, Advisory Council, NIPS & Former Chairman WAPDA
4.	Dr Muhammad Arshad	Co-Founder and CEO of NEW Con. (NC), Consultancy for Water and Environment
5.	Engr Suleman Najib Khan	Vice President Institution of Electrical & Electronics Engineers Pakistan (IEEEP)
6.	Dr. Muhammad Ashraf	Chairman PCRWR
7.	Dr Tariq Mahmood	Principal SCEE, NUST
8.	Mr Muhammad Tahir Anwar	DG Federal Water Management Cell. Ministry of National Food Security and Research
9.	Mr Ahmed Kamal	Chairman Federal Flood Commission
10.	Dr Muhammad Aslam Tahir	Secretary Pakistan Council for Science and Technology (PCST)
11.	Mr. Ahmer Bilal Soofi	President RSIL
12.	Major General Samrez Salik (Retd.)	Former President ISSRA, NDU
13.	Brig Fiaz Hussain Shah	DG National Institute of Disaster Management (NIDM), PhD Scholar CIPS
14.	Abdus Salam Khan	Former Secretary Irrigation Baluchistan & Member Balochistan Public Service Commission





15.	Dr Din Mohammad Kakar	Professor & Dean Faculty of Earth & Environmental Sciences, University of Balochistan
16.	Muhammad Riaz	DG Pakistan Meteorological Department (PMD)
17.	Engr Abid Sheikh	Chief Engineer, Hydro Electric Planning, WAPDA
18.	Rao Irshad Ali Khan	Member Punjab, IRSA
19.	Dr Nasim Rauf	Member Science, Pakistan Council of Scientific and Industrial Research (PCSIR)
20.	Ashfaq Mahmood	Senior Advisor Water Programme, LEAD. Former Secretary Ministry of Water and Power
21.	Dr Muhammad Irfan Khan	Professor, Environmental Sciences Islamic International University
22.	Dr Zaigham Habib	Water and Climate Change Expert; FAO, Consultant
23.	Engr Shamsad Gohar	Former General Manager NE-SPAK.
24.	Helga Ahmad (Katrina Huppert)	Environmentalist
25.	Engr Mushtaq Ahmad Gill	Chief Executive, South Asian Conservation Agriculture Network Services Pakistan (SACAN) Ex DG Water Management
26.	Dr Muhammad Irfan Ashraf	Assistant Professor, Department of Forestry & Range Management Arid University (Climate Change Impact on Forests)
27.	Dr Salman Atif	Assistant Professor IGIS (Geography and Natural Environment), SCEE, NUST
28.	Engr Ammara Mobeen	Assistant Professor, SCEE, NUST
29.	Dr Javed Iqbal	HoD, IGIS, (GIS and RS Application in Natural Resource Management), SCEE, NUST
30.	Dr Hamza Farooq	Professor, NIT, SCEE, NUST



31.	Dr Muhammad Shahid	Assistant Professor, SCEE, NUST
32.	Dr Sajjad Haider	Associate Professor, SCEE, NUST
33.	Dr Muhammad Arshad	HoD & Associate Professor, Environmental Sciences, IESE, SCEE, NUST
34.	Dr Bashir Ahmad	Director Climate Change Alternate Energy & Water Resources Institute (CEWRI)
35.	Simi Kamal	Head of Programs, Pakistan Poverty Alleviation Fund
36.	Muhammad Asif	Principal Scientific Officer, ALP, PARC
37.	Sabeen Younus	Officer, Pakistan Poverty Alleviation Fund
38.	Dr Fouzia Altaf	Research Officer, PCRWR
39.	Kiran Anwaar	Senior Research Officer PCRWR
40.	Ambreen Sadozai	Senior Officer NPSL PCSIR
41.	Shafiqur Rehman	Research Officer, PCRWR



REPORT OF THE ROUNDTABLE DISCUSSION ON

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**MANAGING THE WATERS: APPRAISAL OF  
PAKISTAN'S PROBLEMS AND WAYS FORWARD**

The background features a repeating pattern of interlocking hexagons and stylized leaves. The hexagons are arranged in a grid-like fashion, with some containing smaller hexagons. The leaves are scattered throughout, particularly in the lower half of the page, and are rendered in a light gray color.