Pakistan Economic Forum III

Water Panel

Final Report 2015

(Revised 2016)

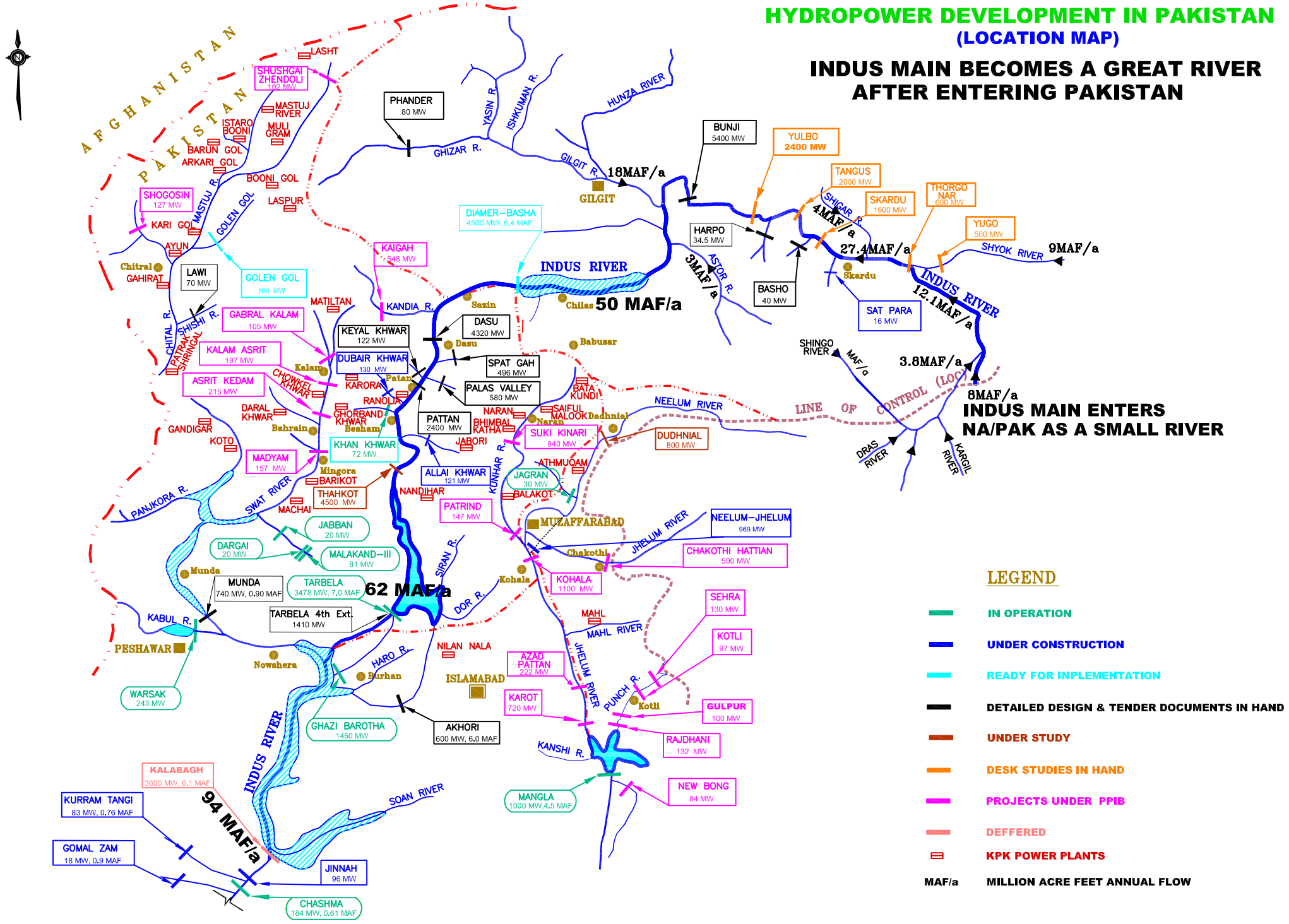
(UPDATED 2018)

Pakistan Economic Forum

The Pakistan Business Council

FOSTERING ECONOMIC GROWTH

(A Company set up under Section 42 of the Companies Ordinance 1984)


HYDROPOWER DEVELOPMENT IN PAKISTAN
(LOCATION MAP)
INDUS MAIN BECOMES A GREAT RIVER
AFTER ENTERING PAKISTAN
AFGHANISTAN
PAKISTAN
LASHT
SHUSHGAI ZHENDOLI 102 MW
MASTUJ RIVER
ISTARO
BOONI
MULI GRAM
BARUN GOL
ARKARI GOL
BOONI GOL
LASPUR
SHOGOSIN 127 MW
KARI GOL
AYUN
Chitral
GAHIRAT
LAWI 70 MW
GOLEN GOL 106 MW
MASTUJ R.
GOLEN GOL
CHITAL R.
SHISHI R.
PATRAK SHRINGAL
GABRAL KALAM 105 MW
KALAM ASRIT 197 MW
ASRIT KEDAM 215 MW
DARAL KHWAR
GANDIGAR
KOTO
MADYAM 157 MW
PANJKORA R.
SWAT RIVER
MACHAI
JABBAN 20 MW
DARGAI 20 MW
Munda
MUNDA 740 MW, 0.90 MAF
TARBELA 3478 MW, 7.0 MAF
TARBELA 4th Ext. 1410 MW
62 MAF/a
KABUL R.
PESHAWAR
Nowshera
WARSAK 243 MW
HARO R.
Burhan
GHAZI BAROTHA 1450 MW
INDUS RIVER
KALABAGH 3600 MW, 6.1 MAF
94 MAF/a
KURRAM TANGI 83 MW, 0.76 MAF
GOMAL ZAM 18 MW, 0.9 MAF
JINNAH 96 MW
CHASHMA 184 MW, 0.61 MAF
SOAN RIVER
PHANDER 80 MW
GHIZAR R.
YASIN R.
ISHKUMAN R.
HUNZA RIVER
GILGIT R.
GILGIT
18MAF/a
BUNJI 5400 MW
YULBO 2400 MW
TANGUS 2000 MW
SKARDU 1600 MW
THORGO NAR 600 MW
YUGO 500 MW
SHIGAR R.
4MAF/a
27.4MAF/a
SHYOK RIVER
9MAF/a
Skardu
INDUS RIVER
12.1MAF/a
HARPO 34.5 MW
3MAF/a
ASTOR R.
BASHO 40 MW
SAT PARA 16 MW
DIAMER–BASHA 4500 MW, 6.4 MAF
INDUS RIVER
Chilas
50 MAF/a
KAIGAH 548 MW
KANDIA R.
Sazin
DASU 4320 MW
Dasu
Babusar
KEYAL KHWAR 122 MW
DUBAIR KHWAR 130 MW
SPAT GAH 496 MW
PALAS VALLEY 580 MW
Patan
KARORA
RANOLIA
CHORBAND KHWAR
Besham
Bahrain
PATTAN 2400 MW
KHAN KHWAR 72 MW
JABORI
Mingora
BARIKOT
THAHKOT 4500 MW
NANDIHAR
ALLAI KHWAR 121 MW
PATRIND 147 MW
KUNHAR R.
NARAN
BHIMBAL
KATHA
SUKI KINARI 840 MW
BATA KUNDI
SAIFUL MALOOK
Naran
Dadhnial
ATHMUQAM
JAGRAN 30 MW
BALAKOT
MUZAFFARABAD
Chakothi
NEELUM RIVER
DUDHNIAL 800 MW
LINE OF CONTROL (LOC)
SHINGO RIVER
MAF/a
3.8MAF/a
8MAF/a
INDUS MAIN ENTERS
NA/PAK AS A SMALL RIVER
DRAS RIVER
KARGIL RIVER
NEELUM–JHELUM 969 MW
JHELUM RIVER
CHAKOTHI HATTIAN 500 MW
SIRAN R.
DOR R.
Kohala
KOHALA 1100 MW
MAHL
MAHL RIVER
SEHRA 130 MW
KOTLI 97 MW
NILAN NALA
AZAD PATTAN 222 MW
ISLAMABAD
KAROT 720 MW
JHELUM RIVER
PUNCH R.
Kotli
GULPUR 100 MW
RAJDHANI 132 MW
AKHORI 600 MW, 6.0 MAF
KANSHI R.
MANGLA 1000 MW,4.5 MAF
NEW BONG 84 MW
LEGEND
IN OPERATION
UNDER CONSTRUCTION
READY FOR INPLEMENTATION
DETAILED DESIGN & TENDER DOCUMENTS IN HAND
UNDER STUDY
DESK STUDIES IN HAND
PROJECTS UNDER PPIB
DEFFERED
KPK POWER PLANTS
MAF/a
MILLION ACRE FEET ANNUAL FLOW
29-08-2018

Water Panel Report 2015

(Revised 2016)

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Note: Reprinting of the November 2015 Water Panel Report in December 2016 was arranged by WRDC (Water Resource Development Council) www.wrdc.com.pk and was edited by HAQ Consult: www.haqconsult.com.

PBC Members:

Abbott – A Promise for Life	AkzoNobel	Allied Bank	Artistic Milliners
Atlas	Bank Alfalah Limited	Cherat Cement	Coca-Cola
Colgate – Palmolive	Dawood Hercules	Descon	efu
English Biscuit Manufacturers	engro corp	faysalbank	Gatron
Getz pharma	gsk GlaxoSmithKline	Gul Ahmed Textile Mills Limited, Karachi	HBL
Hascol	Hubco	ICI Pakistan	interloop
International Industries Ltd.	Indus Group	Toyota Daihatsu – Indus Motor Company Limited	JDW Sugar Mills Ltd.
Lotte	Lucky Cement	Mega Conglomerate	Millat Tractors Ltd.
National Foods Since 1970	Nestlé	Nishat Mills Ltd.	Packages Limited
Pakarab Fertilizers Limited	Pakistan Tobacco Company	Philip Morris International	Saif Group
Sanofi	Sapphire	Siemens	Standard Chartered
Protects What's Good – Tetra Pak	UBL	Unilever	

About the Pakistan Business Council:

The Pakistan Business Council (PBC) is a business policy advocacy forum, representing private-sector businesses that have substantial investments in Pakistan's economy. It was formed in 2005 by 14 (now 47) of Pakistan's largest enterprises, including multinationals, to allow businesses to meaningfully interact with the government and other stakeholders.

The Pakistan Business Council is a pan-industry advocacy group. It is not a trade body, nor does it advocate for any specific business sector. Rather, its key advocacy thrust is on easing barriers to allow Pakistani businesses to compete in regional and global arenas.

The PBC works closely with the relevant government departments, ministries, regulators and institutions, as well as other stakeholders including professional bodies, to develop harmony on major issues which impact the conduct of business in and from Pakistan. As part of its advocacy thrust, the PBC submits research-driven position papers and recommendations to the government on legislation and other government policies affecting businesses. It also serves on various taskforces and committees of the Government of Pakistan, as well as those of the State Bank, the SECP and other regulators, with the objective to provide policy assistance on new initiatives and reforms.

The PBC conducts research, and holds conferences and seminars, to facilitate the flow of relevant information to all stakeholders in order to help create an informed view on the major issues faced by Pakistan.

The PBC's Founding Objectives:

- To provide for the formation and exchange of views on any question connected with the conduct of businesses in and from Pakistan.
- To conduct, organize, set up, administer and manage campaigns, surveys, focus groups, workshops, seminars and field works for carrying out research and raising awareness in regard to matters affecting businesses in Pakistan.
- To acquire, collect, compile, analyze, publish and provide statistics, data analysis and other information relating to businesses of any kind, nature or description and on opportunities for such businesses within and outside Pakistan.
- To promote and facilitate the integration of businesses in Pakistan into the world economy and to encourage the development and growth of Pakistani multinationals.
- To interact with Governments in the economic development of Pakistan and to facilitate, foster and further the economic, social and human resource development of Pakistan

The PBC is a Section 42 not-for-profit Company Limited by Guarantee. Its working is overseen by a Board of Directors elected every three years by the Membership, headed by a Non-Executive Chairman. The day-to-day operations of the PBC are run by a professional secretariat headed by a full-time, paid CEO. More information on the PBC, its members and its workings, can be found on its website: www.pbc.org.pk

About the Pakistan Economic Forum:

Along with great potential, Pakistan also faces great issues and challenges, the gravity and nature of which are constantly in flux. In order to overcome these challenges and for the country to progress, it is essential that the core issues are identified, prioritized and then debated, leading to pragmatic recommendations for the top decision-makers. With this in mind, the PBC sponsors the Pakistan Economic Forum (PEF), a biennial gathering of Pakistan's business and intellectual elite. The PEF aims to identify the most critical problems faced by Pakistan, establishing panels to focus on each major topic. Each panel consists of experts and stakeholders in that particular field, who (following a comprehensive study on the issue at hand) make their recommendations and provide suggestions for the way forward, which are then presented at the main PEF event. The objective is for these studies, facilitated by stakeholder involvement and a concerted media effort, to become part of the national discourse, impacting future government policies.

This year, at the PEF, there are four panels:

Energy: The energy crisis means that Pakistan faces 'weak institutions, inappropriate pricing policies and insufficient public sector investment'. According to government figures, Pakistan's energy demand in 2030 will be 64% greater than its supply. Unless Pakistan moves to address this, the country will not only pay a huge economic cost, but progress towards a stable society will also stagnate. The Energy Panel identified the problems currently faced, and recommended the necessary solutions which will enable Pakistan to meet its energy needs.

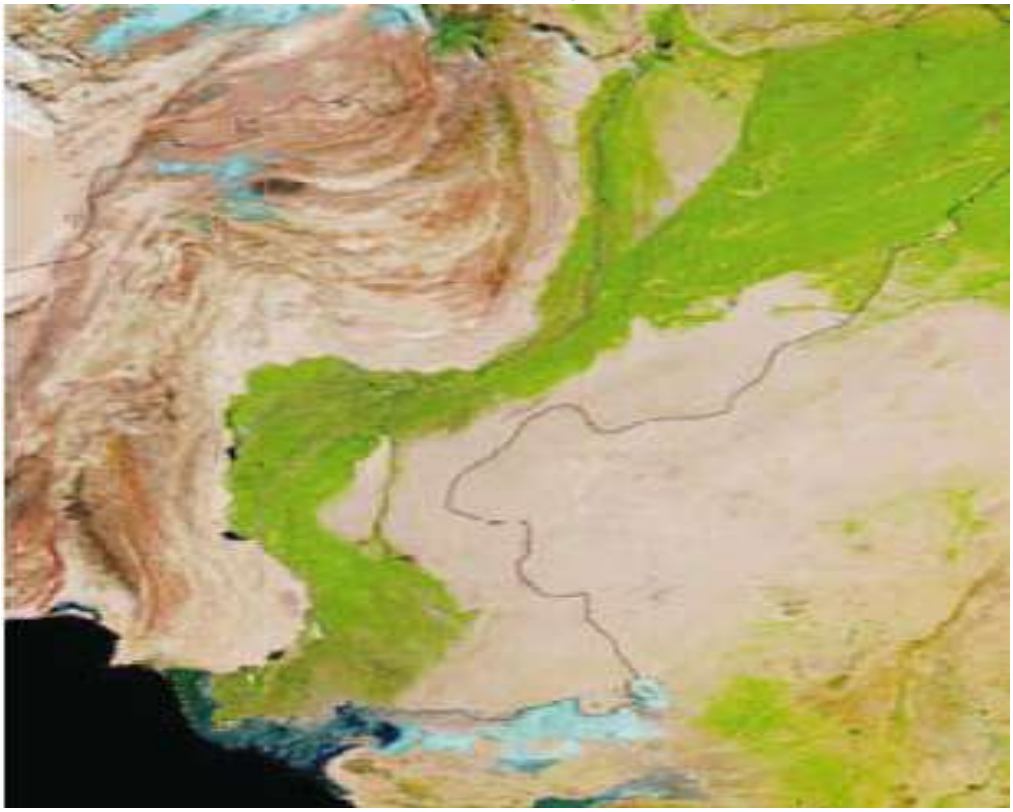
Logistics and Connectivity: Logistical infrastructure covers the assets, installations and processes involving the whole supply chain of flow, stocking and distribution of goods and services, from origin to consumption. Road, air, rail, ports and shipping, pipelines, telecommunication and e-connectivity are therefore integral to effective logistical systems. The Logistics and Connectivity Panel at this year's PEF focused solely on railways, identifying issues which have led to the dismal state of Pakistan Railways today. The panel also made recommendations as to how these problems can be overcome, both today and in the future, with the objective being a well-functioning transport sector which supports fiscal resources, and economic and social growth.

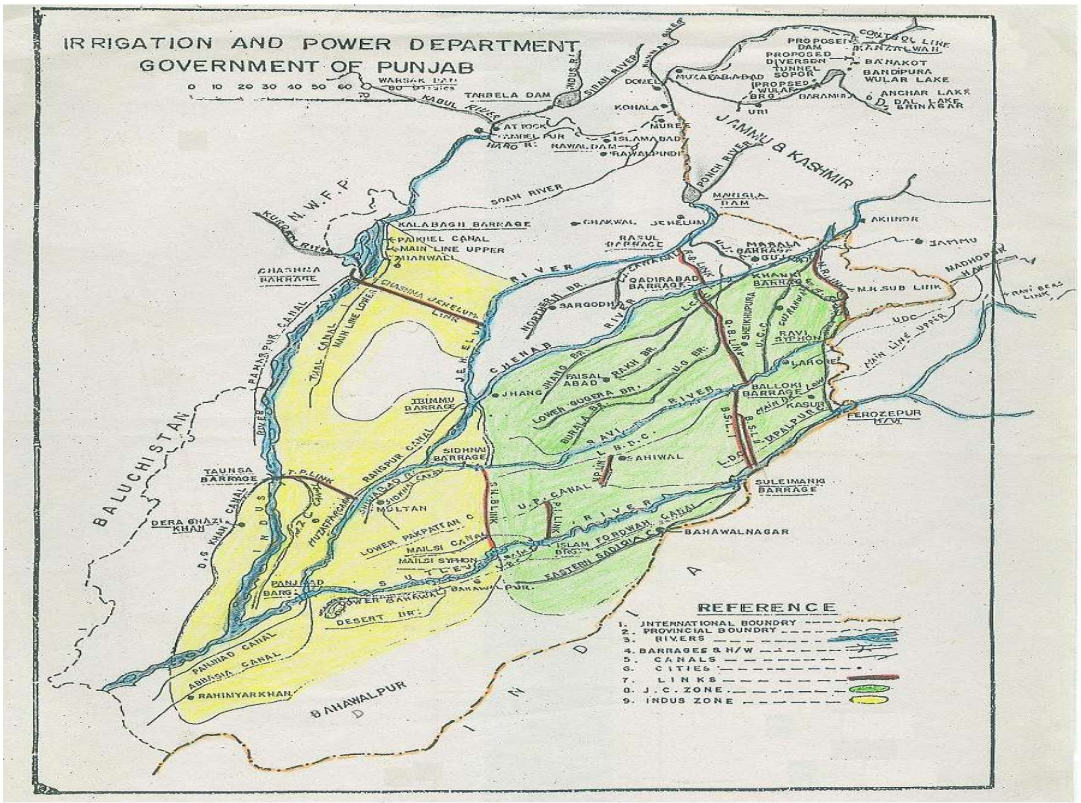
Macroeconomics: Pakistan is facing numerous economic challenges, including high unemployment, rising costs of doing business, an energy shortfall, persistently high poverty levels and dismal social indicators. To respond effectively to these challenges, the government needs effective state machinery that can implement policies for optimal economic and social outcomes. The state machinery can only be made effective with the right people for the job, accountability, effective processes and incentive structures and, most importantly, financial resources. The Macroeconomic Panel identified and expanded upon these challenges, as well as providing recommendations for future planning.

Water: The lack of availability of clean, usable water in Pakistan poses serious issues both commercially, as well as on a social scale. The causes behind this are diverse, ranging from climate change problems, to the poor quality and chemical properties of the water that is available, to a severe neglect of the issues at hand. The Water Panel studied these issues, and identified potential solutions from creating more reservoirs to the recycling and reusing of wastewater in Pakistan.

Appendix: Pakistan from space. Punjab Irrigation network

Pakistan from space





Annexures list on next page.

ANNEXURES:

P.S: River Basins of India (different classifications) on pages 72, 88,136,154,186

The measure of Water quantity & flow rate. Electrical Energy

The water report will include reference to MAF & Cubic Kilometer. The units of flow are cusecs (cubic feet/second written as cfs) or cumecs in the metric system. MAF can be visualized as it is simply one million acres covered by one foot of water. An easy rule: if you multiply MAF by 1.2334 the figures are converted to cubic kilometers. A cubic km is denoted in BCM, because a cubic km is a billion cubic meters (BCM). One cubic meter of water is no small measure. It is a thousand liters and weighs a ton. A continuous flow of 1381.6 c/s for a year conveys ONE MAF or 1.2334 BCM. Electrical energy is measured as the well-known KWh also known as the electrical energy "unit". A 1000GWh is 1bn units.

To understand discharge in acre feet per day (AF/day) note that 1 cfs flow will discharge 1.983 AF/day. To calculate imperial gallons: 1 AF = 1233.4 cub.m (m^3) and convert cub.m into liters. 1 imperial gallon is 4.5461 liters.

Editor: Suleman Najib Khan

ACKNOWLEDGEMENTS

The panel members are grateful for this opportunity to have served the people of Pakistan. Such a venture does bring into focus the message of several noble souls who ardently served the cause of water & the environment. The late Mr. Syed Salar Kirmani, late Dr. G.S. Butt (Lt. Gen Retd) and the sage of Karachi, the late Mr. Ardeshir Cowasjee. Dr. Butt the longest serving WAPDA Chairman had earlier a three decade long involvement in the incredible KKH. Several icons are with us and continue to deliver their clarion calls based on scientific truths.

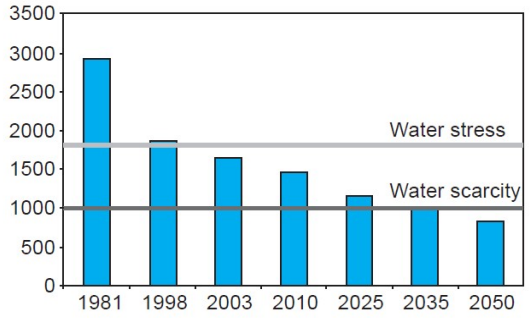
It is not in the nature of the bureaucracy to resist pressure from their superiors. When the subject concerns the crucial "Politics of Water" there can be extreme 'arm-twisting' of subordinates to comply with instructions. A great son of the soil Mr. Chaudhry Mushtaq Ahmad was Chief Engineer (H&WM) of WAPDA's Water Wing at the time of the cataclysmic floods of 2010. The WAPDA Chairman Mr. Shakeel Durrani and his Member Water Mr. Syed Raghib Abbas Shah were both determined that any report from WAPDA should highlight that if the Kalabagh Dam (KBD) would have existed in 2010 the flood damage would have been greater. This brave patriot stayed the course and in the WAPDA Report(Jan 2011) he factually analyzes that the structure of a dam attenuates downstream flows; exactly as the Tarbela Dam achieved. With data on the Attock Gorge & smaller Nowshera Gorge he proves that back-pressure from these constrictions developed as they were unable to pass the deluge and caused upstream flooding. **Clearly, KBD would have been invaluable for flood control downstream.**

The subject is complex. The chair acknowledges that we made new friends in the process of coordinating the report. It was a privilege to have had the association of honorable Dr. Shams ul Mulk for PEF-II (2013) and again for PEF-III (2015) Water reports. The Chair/ Editor also acknowledges the many prolific consultations he had with Engr. M. H. Siddiqi of Punjab Irrigation. **In his 90th year he is still in active service.** Engr. Saeed Akhtar Niazi, a WAPDA mechanical engineer with vast experience of hydropower focused his attention on the run of river Ghazi Barotha HPP. This wonderful project utilizes Indus River downstream of Tarbela to produce upto 1450 MW of low cost power during high flow season. From concept to reality in 15 years he gave his nation a great gift.

A true professional & humanist who has been an inspiration for many is remembered. Dr. John Briscoe the South African born Environmental Engineer passed away on 18 Nov 2014. During his 20 years at the World Bank he had also served as Senior Water Adviser in New Delhi. He grasped the Indian mindset and predicted the present developments/ manipulations of Kashmir waters as a result of Indian military occupation. His writings are a testimony to his great intellect & sensitivity. He is also the Author of "Pakistan's Water Economy Running Dry." From 2009 he was Gordon McKay Professor of Environmental Engineering & Environmental Health at Harvard University. His deep sense of balance & fairness can be observed from just his two short articles at Annexure D. In 2014 he received the 2014 Stockholm Water Prize commonly referred to as the Noble Prize of Water. His fair & incisive style improved perceptions around the IWT 1960 during international arbitrations. Pakistan, Infact the world has lost a great mind. May his soul rest in peace. Ameen

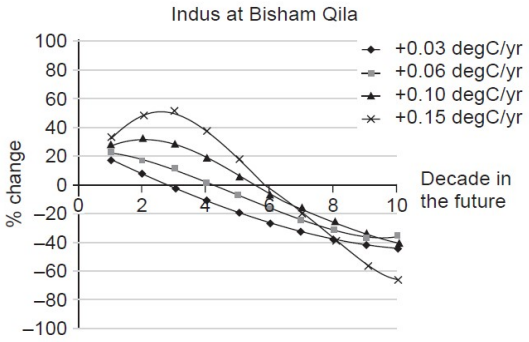
Pakistan Paindabad

Fig. 5: Declining per capita availability of water in Pakistan (cubic meters per capita per year)



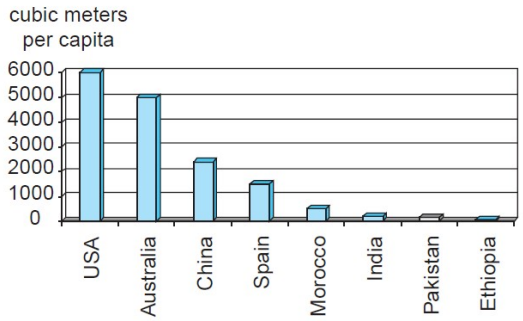
Source: Amir, 2005.

Fig. 8: Predicted changes in Indus flows just above Tarbela



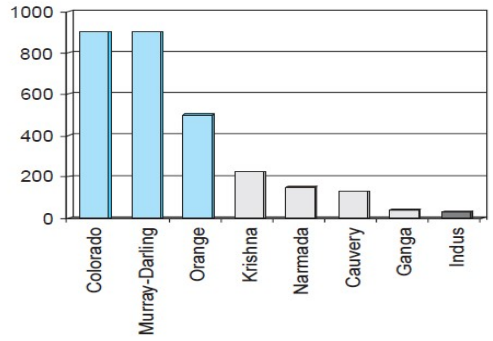
Source: Rees, 2005.

Fig. 9: Storage per capita in different semi-arid countries



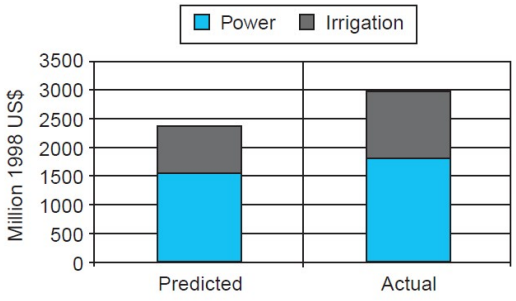
Source: The World Bank analysis of ICOLD data.

Fig. 10: Days of average flow which reservoirs in semi-arid countries can store in different basins



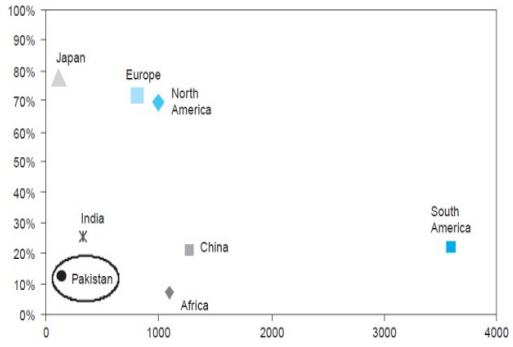
Source: The World Bank analysis of ICOLD and GDRC data.

Fig. 15: Benefits from Tarbela (1975–98)



Source: WCD, 2000.

Fig. 17: The development of economically feasible hydropower potential in Pakistan in international context



Source: The World Bank, 2003.

Courtesy: "PAKISTAN'S Water Economy Running Dry" (John Briscoe • Usman Qamar)

Mr. Suleman Najib Khan
Panel Chair

An Electrical (Power) Engineer & Energy Consultant. He is presently the VP (HQ) of the IEEEP & was earlier its Chairman Lahore Local Center. His experience covers all aspects of Power Engineering; HV (T&D), Industrial controls, Thermal plants & Hydro power plants. Author of institutional reports on energy & water. A major focus on Pakistan's "politics of water". Writes on the strategic hydel : thermal ratio for a sustainable energy mix, on technology management, aquifer recharge, water for human consumption, hydropower & flood control. In 1984-89 part of the USA consultant's team for the first CCPP 600MW at Guddu TPS. In the 1990s part of the Sulzer Hydro team on the 1728 MW Tarbela Dam 3rd HPP extension.

A Distinguished Visiting Faculty (DVF) at NDU, Islamabad. Convener of the landmark National Conference "Water Reservoirs in the National Economy" (Islamabad 09 Feb 1998).Convened dozens of seminars, workshops & conferences since 1997, including "The National Conference on Electric Power Deficit" (UET 29 Oct 2011). Delegate to the Closed Door Conference on Kashmir Waters (New Delhi 28-30 July 2010). Delegate to the Pak-India Water Dialogue (Bangalore 15-17 Feb 2014) a Track-II forum. Member of the Advisory Committee of the Federal Planning Commission since 2013.

Dr. Bashir A. Chandio
Panel Co-Chair

An eminent civil engineer hailing from Sindh province. A former Chairman of PCRWR, Islamabad having extensive knowledge of reservoirs and water resource management. His last appointment was as VC Tando Jam University, Sindh province. He is now living in Hyderabad.

Parvez Ghias

Parvez Ghias is Chief Executive Officer at Indus Motor Company Limited, a joint venture between House of Habib, Toyota Motor Corporation and Toyota Tsusho Corporation engaged in manufacturing and marketing of Toyota brand automobiles.

He also serves as an independent director on the boards of Standard Chartered Bank Ltd., Dawood Hercules Corporation Limited and Injaz Pakistan.

Parvez Ghias is a fellow of the Institute of Chartered Accountants from England & Wales and holds a bachelors degree in Economics and Statistics.

Shams ul Mulk, Ph.D., Honorary
Hilal-i-Imtiaz
Pakistani civil engineer and Technocrat

Shamsul Mulk, Ph.D., HI, is a Pakistani civil engineer and a Technocrat. He was the first WAPDA engineer to become its chairman in May 1994. He also served as the 24th Chief Minister of the KP province under the Military Government of Gen. Musharraf. He was 3rd Chairperson of Board of Governors of Sustainable Development Policy Institute. In December 2010 Mr. Shams ul Mulk was awarded an honorary PhD degree in recognition of his meritorious services in the power & water sectors.

He is a very vocal & strong supporter for the construction of the Kalabagh Dam (KBD). He accuses inter provincial prejudices as well as foreign lobbies that are supporting the anti-Kalabagh dam movements in Sindh and KP provinces. He argues that the worst floods in Nowshera's were in 1929 & 2010 which contradicts ANP propaganda of Nowshera's future flooding due to the proposed KBD.

Shams-ul-Mulk has been associated with the construction of major projects such as Tarbela Dam, Mangla Dam and Ghazi Barotha Hydropower Project. The government awarded him Hilal-i-Imtiaz in 2007. He has been a consultant to the World Bank and was a member of the Technical Committee on Water Resources setup by Gen. Musharraf in 2003 (Report of August 2005). He was the founding Chairman of Pakistan Water Partnership, the country chapter of the Global Water Partnership Stockholm, Sweden. In 2006, he succeeded late Ghulam Ishaq Khan, former President of Pakistan, as the President of the Society for the Promotion of Engineering Sciences & Technology in Pakistan and on Board of Governors of the Ghulam Ishaq Khan Institute of Engineering Sciences & Technology.

Sardar Mohammad Tariq

A former Member Water of WAPDA. An eminent and popular civil engineer hailing from KP province. His advice has been sought by governments & think tanks. Regularly delivered lectures at NUST & UETs etc. A DVF at the NDU. Executive Director/ CEO of the Pakistan Water Partnership (PWP). Advisor PEDO, KP province. Chairman BoD of BARQAAB Consulting Services (Pvt.) Ltd. Lahore.

Sardar Muhammad Tariq has successfully completed a number of consultancies in the field of integrated water resource management, water resource planning, review of environmental sustainability of water development, water supply schemes, water resource chapter of Federal government five year plans, review of Indus basin management model, climate change/ global warming, drought occurrence and mitigation, etc. He has served as Team Leader on multipurpose water resource development project funded by World Bank, Asian Development Bank, Saudi Government, DFID in Pakistan and abroad. Apart from his technical services, he also remained responsible for human resource development. He is also an author of the National Water Vision 2025 pertaining to water resources and hydropower development of Pakistan. He headed the Water Wing of WAPDA, the premier organization for water resource management and 27,000 engineers & technicians worked under him.

He was the head of a team responsible for training Malaysian and Indonesian engineers on safety inspections of HPPs. He authored +100 technical papers including policy review papers for the World Bank and participated in +200 international and national seminars, workshops & consultation. His countries of work experience include Indonesia, Malaysia, Sri Lanka, United Kingdom & Pakistan.

Mr. Muhammad Shamshad Gohar
Ground Water Specialist

Shamshad Gohar has been a practicing professional Hydro-geologist since 1962 in and outside Pakistan with a large experience in Middle East and African countries. Retired as General Manager from NESPAK in 2001; has provided technical assistance to WB, PPAF, ADB, FAO, JBIC, FAO, UNICEF and public sector institutions in the field of Planning, Development and Management of Water Resources Projects, Surface & Groundwater Development & Management, Drainage and Reclamation Projects. Remains active as a consultant of hydrology & GW.

As a Gift from Almighty - he participated in a study on the impact of Al Shamiyah Development Project, on Zam Zam Well in Makkah Mukkarama in July, 2005. He was also the GW expert for the FODP / ADB funded study under the leadership of the legendary Prof. John Briscoe of Harvard University. The report was completed in 2013. Mr. Gohar has a comprehensive understanding of the GW resource.

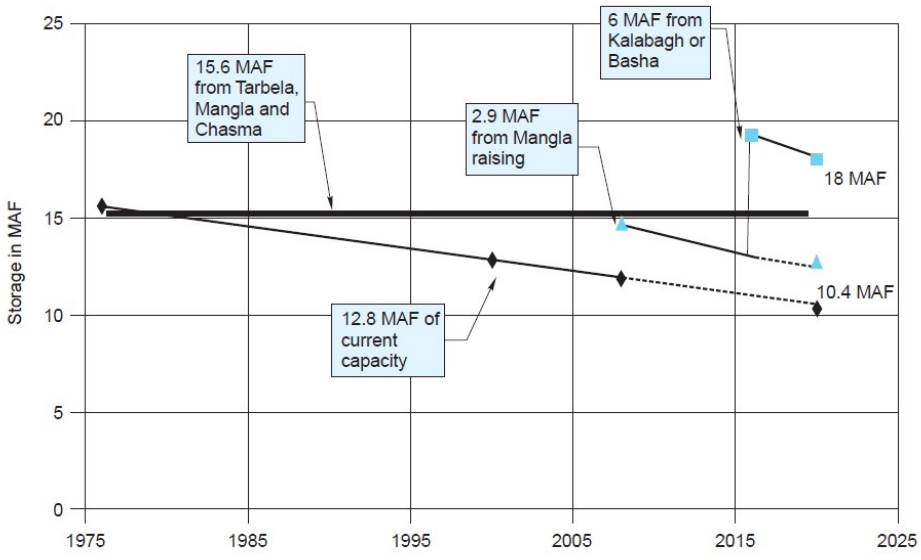
Begum Dr. Zaigham Habib
Consultant -Water Resources & Environment

Dr. Zaigham Habib has worked with international and national research and development organizations. Her areas of expertise include trans-boundary water sharing, basin and local level water management, hydraulic & hydrological analysis and emerging climate change challenges. She is an independent consultant on hydrology and water resources. She has carried out modeling studies of the Indus Basin to analyze water distribution, agriculture performance, environmental flows, rainfall runoff and hydraulic improvement of the LBOD drainage system.

She has been extensively involved in research and local adaptation of knowledge-based tools. Dr. Habib has published research on water resources assessment, water allocations, water use efficiencies from the farm to the basin level, performance evaluation of irrigation infrastructure, environmental flows for the Indus and tributary rivers and institutional management of water resources in the Indus Basin. She has been a member of think tanks and fora on climate change, provincial water disputes, trans-boundary water issues and water resources. She has represented Pakistan at Track-II forums including the Pak-India Water Dialogue, Bangalore (Feb 2014), another Track-II forum.

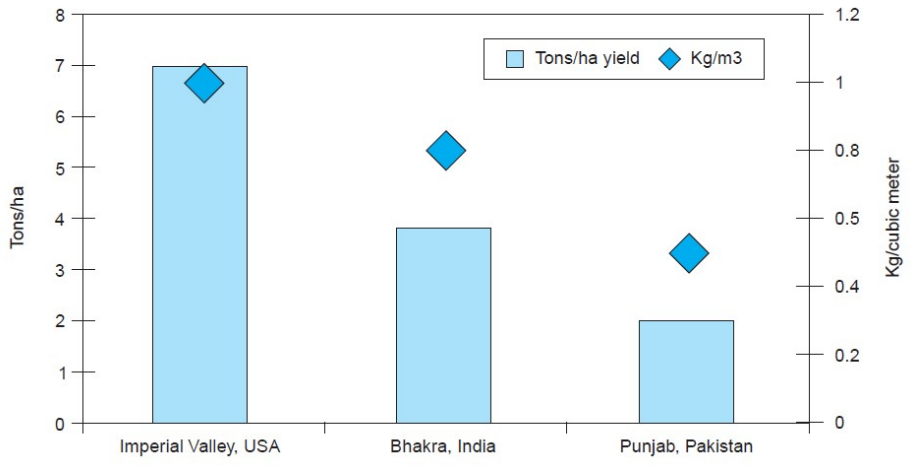
Her research publications, conference papers and articles include: Troubled Waters of Pakistan, Water Worries (of Pakistan), Policy and Strategic Lessons from the evolution of Indus Basin, Pakistan: Indus Basin Water Issues, Scope for Reallocation of Rivers Waters for Agriculture in the Indus Basin, Containing salinity through irrigation management: the case of the Fordwah area in Pakistan, Spatial Distribution of Reference and Potential Evapotranspiration Across the Indus Basin Irrigation Systems, Basin-Level Use and Productivity of Water: Examples from South Asia, Hydraulic simulations to evaluate and predict design and operation of the Chashma Right Bank Canal, Crop-based irrigation operations in the North West Frontier Province of Pakistan. Vol.II: Research approach and interpretation. Final Report, Action plan for operations support of the Pehur High-Level Canal (PHLC) Project: 1 January 1995 to 31 December 2001 submitted to Irrigation Department North West Frontier Province, Unsteady flow simulation of the designed Pehur High Level Canal and proposed remodeling of Machai and Maira branch canals, North West Frontier Province, Pakistan.

Fig. 12: Sedimentation and storage capacity



Source: The World Bank, 2003.

Fig. 13: Wheat yields per unit of land and water



Source: Ahmad, 2005.

Courtesy: "PAKISTAN'S Water Economy Running Dry" (John Briscoe • Usman Qamar)

ADB	Asian Development Bank
AJ&K	Azad Jammu & Kashmir (Pakistani Kashmir)
BCM	Billion Cubic Meters (or cubic km). One BCM is 1,000 MCM
CIBSA	Commission for the Indus Basin Strategic Analysis
DBD	Diamer Basha Dam
EPC	Engineering, Procurement and Construction
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FODP	Friends of Democrat Pakistan
GDP	Gross Domestic Product
GLOF	Glacier Based Outburst Flood
GOP	Government of Pakistan
GPCD	Gallons Per Capita per Day
GW	Ground Water
GWh	Giga Watt Hour
Ha	hectare (2.5 acres)
HFO	Heavy Fuel Oil (or RFO)
HKH	Hindu-Kush, Karakorum, Himalayas
HPP	Hydro Power Project
Hydel	Hydroelectric
IBIS	Indus Basin Irrigation System
ICID	International Commission on Irrigation and Drainage
ICOLD	International Convention on Large Dams
IHK	Indian Held Jammu & Kashmir
IPCC	Intergovernmental Panel on Climate Change
IPD	Irrigation and Power Department
IPP	Independent Power Producer
IRSA	Indus River System Authority
IWA	Indian Water Aggression
IWC	Indus Water Commission
IWMI	International Water Management Institute
IWT	Indus Waters Treaty 1960
KBD	Kala Bagh Dam (or KDP Kalabagh Dam Project)
KKH	Karakoram Highway
KP	Khyber PakhtunKhwa (former NWFP) province
KV	Kilo Volt
KWh	Kilo Watt Hour (measure of electrical energy)
Lac	100,000 (measure used in the Indian Sub-continent)
Ma	Million acres
MAF	Million Acre Feet
MICS	Multiple Index Cluster Survey
MPH	Miles per Hour
MW	Mega Watts
NEAC	NESPAK-ACE Consortium
NESPAK	National Engineering Services Pakistan
NGO	Non-Government Organization
NRL	Northern River Linking (Project of India)
NWC	National and Provincial Water Councils
PC	Planning Commission
PCA	Permanent Court of Arbitration

PCIW	Pakistan Commissioner for Indus Waters
PCRWR	Pakistan Council for Research in Water Resources.
PIDs	Provincial Irrigation Departments
PPSGDP	Punjab Private Sector Groundwater Development Project
PTW	Private Tube Wells
PWF	Provincial Water Frameworks
RFO	Residual Fuel Oil (or HFO)
ROR	Run of River
SCARP	Salinity Control and Reclamation Program
SGW	Saline Ground Water
SW	Surface Water
TBMs	Tunnel Boring Machines
ToR	Terms of Reference
UNICEF	United Nations International Children's Emergency Fund
USBR	United States Bureau of Reclamation
USD	United States Dollar
USSR	Union of Soviet Socialist Republics
WAA	Water Apportionment Accord
WAPDA	Water and Power Development Authority
WASA	Water and Sanitation Authority
WB	World Bank
WHO	World Health Organization
WRDC	Water Resource Development Council, a Lahore based NGO.
WSTF	Water Sector Task Force

A clarification about IBIS (Indus Basin Irrigation System)

The world's largest contiguous irrigation system at the time of partition came under instant stress as control of the three Eastern Rivers (Ravi, Sutlej & Beas) came into the hands of the Upper-Riparian/ India. While the genesis of the Indus Waters Treaty 1960 was laid in 1952 with an initiative by President H. Truman involving the World Bank as facilitator (& guarantor) during an eight years period which allowed the Indian & Pakistan delegations to talk & negotiate. The Pakistanis built 12 link canals. Five before the Treaty of September 1960 and seven after Treaty to transfer waters from Western Rivers to basically keep the main Eastern River (Ravi & Sutlej) alive within Pakistan. The two most critical link canals for the Southern Cotton belt being:

TP link canal: TAUNSA (Indus) - PANJNAD River (Jhelum & Chenab combined) link.
CJ link canal: CHASHMA (Indus) - JHELUM link.

It is also clarified that IRSA (Indus River System Authority) based on the March 1991 Water Accord is between the four provinces and establishes an equitable water sharing arrangement of the Indus Basin resource within Pakistan. In 1997/2001 a regulatory network for Ground Water (GW) was created but nobody wants to own the GW resource. The aquifers are over-exploited and now highly contaminated South of the Potohar.

INTRODUCTION

Pakistan has been flying blind in the water sector since several decades. Water is our main endowment but there is no continuity in policy directions or even an attempt to have a comprehensive appreciation of the past and future water scenarios. With help from the World Bank and USA, we created a great vehicle in 1958 to harness the potential of the Indus river basin. WAPDA was modeled on America's successful TVA, a seven states initiative of 1933 that brought USA out of recession. In 1969, WAPDA's annual budget was nearly 50% higher than the Federal budget of United Pakistan. What happened suddenly to our green revolution that was being taught to European schoolchildren in the 1960's? Today inspite of the plunder of our Ground Water Resource we cannot have enough irrigation water to maximize the irrigated agriculture output. The dream of going beyond the 42mn acres of irrigated croplands remains a mirage. At least 21mn acres are available but remain fallow since 1947 due to lack of irrigation water. Did we need to so excessively over-exploit the ancient & priceless sweet water aquifers during the last 45 years? It must be understood that surface hydro flows & storages are the basic source of GW Recharge. Rainfall being the other main source in the hydrologic cycle. The ever deeper mining of GW has resulted in arsenic & heavy metal contamination of the aquifers, far exceeding WHO recommendations. The untreated discharge of raw sewage, as well as industrial & agriculture effluents into surface channels & GW aquifers has in many cases caused an irreversible deterioration of water quality. Dams create storages and do not consume water. The future scenario is very frightening. The nation has been unable to analyze the impact of the lack of planning of our water endowment. A single basin country with the planet's sixth largest population cannot afford this state of virtual paralysis with respect to its hydro resource. Wake up.

The geographical & hydrological realities cannot be changed. Six of the eight major tributaries of the Indus Main are in control of one upper riparian neighbor, India. Our relentless adversary has her undeniable compulsions. There were reportedly 400 mn Indians without electric power in early 2013. A population of over 1.25 bn souls having a strong system of governance which manifests itself in continuity of selfish initiatives. Water is an article of deep faith with them. In sharp contrast to our state of deep apathy. Both Nepal and Bangladesh have also suffered at their hands. How do we stop them from further attrition of our water endowment? Can we as a nation finally get to understand the deadly consequences of our internal "Politics of Water". Clearly there is a nexus here. We have an active fifth column which is behind decades of mischief. These people refuse to believe the leading experts in hydrology, in environmental sciences, in geo-physics, in hydropower, in hydraulics because they either wish to damage Pakistan irreparably or simply consider their own regional interests to be above the common national interest. Tragically the Federal Authorities have always turned a blind eye to these regional "lobbies". The obvious result is that today even water for human consumption is scarce or seriously polluted; from the hills of Malakand to the coast of Karachi/ Mekran. The economy weighed down by an all pervasive energy crisis as we ignored large dams. Agricultural growth blocked by non-existent reservoirs & depleted aquifers. At the mercy of floods related to Global Warming simply due to the lack of high dams & major storages. We have tragically not built one in 40 years while our population tripled! Can we reverse the poverty cycle?

"Water is life" yet our nation refuses to wake up and create a policy on war footing which will lead to economic & social harmony. Water is the most economical source of electrical energy, yet we are unable to resurrect the hydel : thermal ratio of 70:30; long decided as a national priority. Can we deny that lack of water reservoirs has caused over a trillion USD equivalent of economic loss in the last some thirty years; which now manifests itself as the energy crisis, the basic cause of the economic paralysis & un-sustainability. It has caused inter provincial tensions and one of the major reasons of the militancy & extremism in our society. This crisis has to be remedied and we will have to take the "bull by the horn" otherwise our adversary under its own compulsions will continue to commit "water-aggression". The lesson of Bangalore Feb 2014 is simply that India now seeks every pretext to bypass the letter & spirit of the IWT 1960. They started to call it a "limited agreement" not because they wish to remedy its inhuman provisions such as lack of "environmental flows" for Pakistan but as a pretext to further develop infrastructure to divert our waters in IHK. They now claim that "ground water" was not a part of the IWT 1960. Adding yet another very ominous dimension to their water aggression agenda. The adversary is convinced that we will not understand & cannot protect our interests in this realm. They denied (Bangalore Feb-2014) that

there is glacier retreat in IHK & subsequently there are no global warming flows. Srinagar was ironically flooded in the summers of 2014. Their statements defy logic & common sense. The typical mindset of a bully.

The outside world wants to know the root cause of the Hindu-Muslim divide and why do they observe the deep resentment the Hindu clergy & politicians in India have for the Muslim people. No doubt the Hindu religion is an ancient way of life; in harmony with nature but the caste system is very oppressive. Muslims are untouchables. India has produced great scientists, mathematicians & artists but the Muslim civilization experienced its "golden age" when the rest of the world was in the "dark ages." From Spain to China some of the most important discoveries (in sciences, mathematics, medicine) were made by Muslims that directly influenced the coming of the first industrial revolution a few centuries later. Muslims were not barbarians. The entry of the Mughal Dynasty was as usual for those times; a military conquest. Emperor Babur, first Mughal emperor of India (1526-1530 AD) had come from a region in Central Asia. He claimed direct descent from Genghis Khan, a Mongol and Timur, a Turk. Whatever their origins the Mughals became eventually Indianized just as the preceding Afghan settlers (and marauders.) They did not resort to forced conversions of Hindus. They married upper caste Rajput women. They however ignored the pursuit of modern education. It is a fact that Genghis Khan or his grandson Hulagu Khan were not Muslims and the later attacked the Abbasid Caliphate and destroyed Baghdad. The Indians are deeply conscious of history, said Col. Dr. Tareen and they perceive that they underwent oppression for 1000 years at the hands of Muslim rulers. The Indian Military intervention in former East Pakistan (1971) was declared by them as their revenge for the third battle of Panipat. Can they justify the military occupation of Muslim majority Jammu & Kashmir at the time of partition in 1947? India has since resisted implementing the 1948 UN Resolution promising self-determination through a plebiscite in IHK. It has not happened and merciless oppression continues in IHK. India realizes that IHK is a choke-point for our surface waters. Their activities in IHK are generally surreptitious &inhumane. Are we witnessing the genesis of a nuclear Armageddon?

Our mission should be to focus Indian and world attention on the spirit of the Indus Waters Treaty 1960 so that violations & transgressions can be checked ab-initio. Indians are not expected to inhibit residents of IHK or East Punjab to reduce the excessive pumping of Chenab waters. The Indians have to change their mindset. Pakistanis have to eliminate any traces of superiority. Renegotiation of the IWT 1960 is not possible because the Indians will not discuss the ownership of the three eastern rivers. Indian official strategy is leading to history's greatest genocide & this must be reversed for the sake of all people in the region and beyond. Mr. John Briscoe correctly hoped for an Indian Mandella. Let us pray for one otherwise both resultant scenarios are very frightening. An economically crippled Pakistan obviously prone to separatist intrigues (or nuclear Armageddon.)

Where is our salvation? Clearly it requires a joint civil-military effort. The best and brightest in a grand coalition to monitor the hydrologic cycle of the region. Our panel presents 18 Chapters. In addition there are included 6 Annexures which discuss related issues in some detail. The first two Annexures include statements by national icons including Engr. Shams ul Mulk, Sardar M. Tariq, Shamshad Gohar & Begum Dr. Zaigham Habib. All of them are professionals & qualified to speak on the broad spectrum of "water". Strengthening of the Pakistan Commissioner on Indus Waters (PCIW) remains a top priority together with rehabilitation of WAPDA our Economic Headquarters. Both are vital cogs. The concept of CIBSA as a counter weight to the ICIW & ICID becomes a national priority. The concept of the Great Indus Cascade (2015-2040) is presented in Annexure-F. It outlines the great opportunities for storage projects and hydropower. Chapter 18 covers water& wastewater recycling. Environmental degradation is leading to severe ecological damage. The population south of the Potohar is in the midst of a health epidemic manifesting itself through hepatitis and very high rate of cancers.

In a recent TV talk-show one of India's top media person stated "Pakistan is now a gutter." No doubt the ecological war being waged by the Upper-Riparian has also devastated large tracts of agricultural land in South Punjab and denied water to the North West KP province. By blocking the construction of large dams since +40 years she has also compelled us to over-exploit the aquifers which in the process have been seriously degraded. She projects to the outside world her "great civilization" but treats her minorities & neighbors as untouchables. We will have to stand up to this tyranny & protect our sovereign rights on the Indus Basin Waters. Above all we must first understand the truth. For the Indians, IWT always meant: India Wanted Time. Wake up.

Chair/Editor

EXECUTIVE SUMMARY (APPENDED TOR & RECOMMENDATIONS*)*

Water sustains all forms of life but today the hydro infrastructure is also critical to our economy. It provides part of our drinking water and it is the basis for irrigated agriculture responsible for +90% of the nation's agricultural output including cotton. It has the potential to effectively solve our energy requirements. One of nine countries on the planet that can generate above 50% of their energy needs, in the 21st Century from hydropower. More infrastructure is vital to control floods that are being undeniably caused by Global Warming/ glacier retreat. The same reservoirs will store the precious resource as our HKH glaciers are irreversibly diminished. India is spending over USD 212 bn on the NRL project to bring these additional waters from their northern rim highland states (including IHK) to all the major & minor basins of the Indian Union. A huge network of canals is to link all 31 basins. We remain oblivious of this impending catastrophe and sleep blissfully. Is it thanks to our fifth column or are we an illiterate, self-indulgent nation moving blind-folded in denial of the ground realities? No doubt we also need to understand & address the aquatic and water-dependent ecosystems as we plan the indispensable hydro based infrastructures. Degradation of ecosystems must not be allowed using a trade-off regime.

Water scarcity & hydrologic scenario. Pakistan's surface flows in the Indus Basin System average 145MAF annually. Not included are the western nallahs / streams that flow basically during monsoons and can average 05 to 10 MAF depending on the wet or dry cycles. Water mined from underground aquifers which is around 40MAF annually is proving to be not a true renewable resource. There is negligible rain water harvesting in the Northern zones of Pakistan. The South including Baluchistan is semi-arid/ desert. In comparison the Indian Federation although very secretive about its water data is reportedly having an annual surface flow of 750 MAF in its main rivers. The figures for aquifer mining are not available. Since most of Northern, Central, Eastern& Southern India is blessed with extensive precipitation they have developed sophisticated rain harvesting methods. Practiced in the entire northern rim highland states as well as South India where they refer to it as "tank irrigation". It is a fallacy that Pakistan per capita water availability is close to the Indian average. This may have been close to the truth in 1947 but the situation has deteriorated drastically within Pakistan. It is now close to one third of the Indian average. This average is dramatically reduced for the end user when we consider the net availability from the reservoirs. Pak reservoirs have about 8% storage capacity of their surface flows while India is close to achieving +40% of its declared surface flows. My personal experience at the Closed door Conference on Kashmir Waters in New Delhi during July 2010 confirmed the views of Pak elders including late Engr. B. A. Malik, late Dr. G. S. Butt and late Syed Salar Kirmani. Pakistan has lost or given away or simply been cheated of its water rights every time there has been a face-off with the Indians. Perhaps the Indians worship a water god while we have been historically callous. The Indians want an IWT-2 as they have the network to support them. A 69 years history of water aggression by India the upper riparian is genocide in slow motion. Let us analyze it.

Indian Water Aggression (IWA). India's first P.M. Pandit Jawarharlal Nehru said "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 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 & in tandem the attrition of all our hydro based economic activities. The military occupation of Kashmir was the start of the Indian Water Aggression strategy 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 the 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 & unprecedented policy of taking the entire flow of the three Punjab Rivers (Ravi, Beas & Sutlej) also called the Eastern Rivers. The Indus Waters Treaty (IWT) signed on 19 Sep 1960 was a terrible tragedy for West Punjab & the nation in general. From the 33MAF annual flow of Eastern Rivers the historic share of West Punjab was 27MAF which reduced to 26MAF at the time of the treaty. Pakistan lost close to 20% of its surface flows till eternity. Bureaucrat Mr. G. Mueenuddin, Pakistan's head of the Indus Waters

Delegation to Washington DC was no match for India's hydro expert Mr. N. D. Gulhati. Engr. B. A. Malik's "Indus Waters Treaty in Retrospect" published in 2005 is an accurate account of the genesis of this cruel treaty. The lower riparian Pakistan was expected to "beg for water" using the exact statement of the Indian establishment when they shut off Central &South Punjab's lifeline using Madhopur Headworks on the Ravi and Depalpur canal from Ferozepur Headworks on the Sutlej, both in Indian Punjab. No thanks to the Radcliffe Partition Award. There is no known physical phenomenon whereby Pakistan can transgress & cheat under the IWT 1960. Engr. M. H. Siddqui said "the Pakistanis went to discuss two canals but ended up giving three rivers." Such is the cruel reality for the lower riparian. The period 1960 to 1971 was spent in the Indian obsession to trash "the two nation theory" and their conspiratorial role became clear when their military forces joined the civilian uprising in former East Pakistan. The Indians have orchestrated the anti KBD movement since culminating in several so called democratic interventions by their agents. Prof. John Briscoe's incisive thesis "War or Peace on the Indus?" and his book "Pakistan's Water Economy Running Dry" confirm the apprehensions of Mr. David Lillienthal's (TVA) report of Aug 1951 prepared on the instructions of President Truman. The options for Pakistan:

A. **Strategizing water issues & a possible response.** The tools at Pakistan's disposal are woefully inadequate. Every encounter on the hydro front has ended in defeat. Yes there were technical retreats by the upper riparian but in good time they succeeded to either steal our endowment or block our progress on our own irrigation assets. I calculate they have inflicted an economic loss of over a trillion USD equivalent by blocking Pakistan's mega dams & its tributaries after 1974. Today the KBD project, acknowledged by world experts as the best hydro project site in Asia and probably the only non-silting dam site in the world stands blocked as the Pak nation awaits a "consensus"(political consensus.) The upstream Diamer Basha Dam (DBD) is redesigned as a poor alternate to KBD. In the process configured as an extremely dangerous and unsafe structure. The belligerents expect that this would be a double blow to Pakistan's economy and infact make its existence highly precarious. Instead of a lower & safer Concrete Faced Rockfilled Dam (CFRD) Arch structure, we get a light RCC dam structure with an unprecedented 271 meters height. Storing water at a crest level of 1160 meters asl, using a PVC membrane for seepage control. Imagine the destructive force of over 10bn tonnes (10 cubic km) of water hurtling down from around 3,900 ft altitude. Dr. G. S. Butt (Lt. Gen. Retd) described this doomsday scenario in his 2004 letters to General Musharraf. Refer Chapter 15. The 8 Oct 2005 earthquake in our Northern Areas & the 12 May 2008 reservoir induced earthquake in Sichuan may not be forgotten. Has anyone ever identified the Machiavellian tactics employed by the Indians to create a historical nexus with the World Bank's Greater Kashmir policy. Our Northern Areas are not a part of Jammu & Kashmir. The Indian objective is apparent; deny Pakistan any multi-lateral financing.

B. **The ICID menace & the consortium of traitors.** There is no answer to the Indian ICID and here lies the administrative fault line in Pakistan. Punjab for a few years had been excluded from the Indus Waters Treaty issues although they are the most affected by Indian transgressions. Punjab Provincial Irrigation Ministry is retaining in service the honorable Mr. M. H. Siddiqui a +90 years old engineer who has been declared indispensable due to his knowledge of the Punjab irrigation network & the IWT 1960. A state of tragic apathy exists. IRSA our organization for Indus waters may not be controlled by one province. The TP & CJ link canals are also vital for South Punjab's cotton belt. An organization has to be created overnight to understand, analyze and respond to the Indian transgressions in IHK. Internally this organization must be able to educate the people of Pakistan about the hydro truths. The deliberate & treacherous mis-interpretations of IWT 1960 cannot be allowed. The Indians desire for an IWT-2 is not acceptable. A fight back must start at once since the dangers to Pakistan's existence are clear.

If the Indians are not intending to divert Pak waters from IHK into East Punjab then let them open the entire valley to inspection by UN or WB experts. Their Northern River Link (NRL) USD 212bn project is predicated on violations of the IWT 1960. In July 2010 at the "Closed Door Conference on Kashmir Waters" the Indian side was willing to create a joint commission for study of the IHK watershed. They had agreed during the 29/30 July Water Conference in New Delhi to have a joint study of the IHK water-shed. Misguided philosophers such as Mr. Rafay Alam have diluted the impact of the hydrological reality. His thesis "New approach to the Indus Treaty" is that he wants both nations to share the Indus basin through a joint management process. Due to this naive approach he recommends to let India

build run-of-river power houses in IHK so Pakistan may purchase Indian electricity. He describes talks on Kashmir as "rhetoric". Instead of becoming an Indian colony we must cleanse this nation of its fifth column & use our hydro resource by building the Indus Cascade on a war footing.

C. **CIBSA ~ long overdue.** If CIBSA existed the 2007 tragic defeat on Baglihar-I (450 MW) at the hands of the Neutral Expert would be impossible. This Indian project on the Chenab river involving a dam with low level orifices is a violation of the IWT 1960. It was sheer in competence of the PCIW &his team that could not defend Pak hydro rights under the IWT 1960. Similarly the Indian Kishenganga (KG) involving a power tunnel from Kishenganga (Neelumriver in Pakistan) to a power house on the Bonar Nallah inside IHK could have been blocked with a timely response to the Indian memo of June 1994. Several surprises are still in store as the PCIW secretariat is incapable of checkmating and defending Pakistan's position from the incessant onslaught of Indian ICIW and ICID combined force. It is a fact that WAPDA's Hydro Electric Projects Organization (HEPO) is not consulted by PCIW after 1988.

If CIBSA had existed the most expensive HPP in history would not have been permitted. The longer tunnel option Neelum Jhelum HPP (NJHPP) is heading to be the World's most expensive HPP. It was started impulsively after the case of Pakistan against India's KG HPP was already a lost cause. In 1994 India had the legal upper hand and had snatched the water rights for the KG HPP because of the incompetence of PCIW. The decision of the Permanent Court of Arbitration (PCA) as received in February 2013 and the complete decision in December 2013 were simply a fait accompli. It is our prediction that the downstream project inside AJK known as the Neelum Jhelum Hydropower Project (NJHPP) which involves nearly 60 km of tunneling including tunneling below the Jhelum will cost more than USD 5 billion when commissioned. The expected power rating of 969 MW will not be achieved due to higher hydraulic losses. The expected energy output of 5,000 GWh (5 Bn units) will reduce drastically during the seven (07) months of low flood season (mid August to mid March) when India will only permit 9 cumecs (318 cusecs) flow as decided by the final PCA judgment of December 2013. Infact 86.8% of water representing nearly 0.9 MAF will be diverted by the Indian KG HPP to the Bonar Nallah and effectively to the Wullar lake also inside IHK. It is clear that no one will take responsibility for this financial disaster of NJHPP because its main proponents in WAPDA included Ex-Chairmen Tariq Hameed & successor Shakeel Durrani both misguided by Ex-Member Water Raghib Abbas Shah.

If CIBSA had existed the T-4 HPP extension of Tarbela Dam would remain a 960 MW installed capacity HPP capable of 2000 GWh (2 Bn units annual). The new enlarged rating of 1410 MW will not bring additional hydro based annual energy. The cruel bluff being enacted by the same consultants of Tarbela T-4 HPP project now claim to have designed another HPP extension (T-5 HPP) of Tarbela Dam using the irrigation 5th tunnel. WAPDA has given the "go head" and the design has been approved by CDWP/ Planning Commission **without a feasibility study**. This project will be a criminal act as surplus water will not be available for this project whenever any upstream project on the Indus is ready. Also the Akhori off-channel storage project designed to take surplus flows of Tarbela reservoir would stand eliminated. Infact downstream Akhori off-channel storage is the vital replacement reservoir for the fast silting Tarbela reservoir, presently the only dam on the Indus Main. Are powerhouse extensions on main dams built for flood seasons? The T-5 Project would endanger the Tarbela spillway as the inevitable higher intake (for sediment free water) will be constructed in close proximity of the spillway. All the drawbacks of a T-5 HPP Extension of Tarbela are detailed in Chapter 16, focusing on WAPDA.

D. **The Water Report in a few lines.** The Indian mindset has been finally documented by their Chairman of letters. The highly celebrated Mr. Brahma Chellaney. He has left nothing to the imagination with his book: "Water, Asia's New Battleground" (Harper Collins Publishers India) 2011.

His thesis is India's Kashmir policy based on military occupation of IHK (control of three Western Rivers) and the 100% ownership of the three Eastern Rivers (usurped through IWT 1960) is to debilitate Pak Punjab's Agriculture, the bread basket of Pakistan. His invidious advice written brazenly for our smaller provinces is a clear attempt to block consensus on large dams.

Chair/Editor

TOR WITH RECOMMENDATIONS OF PANEL

TOR1. To understand the endowment of the water resources of Pakistan. To evaluate the value of water for Pakistan's economy when utilized for irrigated agriculture, industrial and municipal purposes. Indeed "water is life" and this is a hypothetical analysis. Any study of value of water must include the value of the irrigation infrastructure. The asset base known as the IBIS (Indus Basin Irrigation System) together with the infrastructure owned by WAPDA i.e. the dams, the barrages and the ancillary irrigation assets as existing. The gross water quantity must include surface waters as well as ground water resource.

TOR2. To understand the letter & spirit of the Indus Waters Treaty 1960. What are the causes for the serious attrition of the inflows of the three Western Rivers, Indus, Jhelum& Chenab as observed during the last decade into Pakistan? Will India agree to share flow data of these three rivers and their tributaries as they flow through IHK. In July 2010 at a conference in New Delhi the Indians had recommended a joint study of the watershed. In Bangalore (Feb 2014) the Indians start to call IWT 1960 a limited agreement that does not cover groundwater (GW). Indeed a dangerous concept that must be repudiated.

TOR3. Can Pakistan sustainably increase productivity of its land and water through improved water management? However it has to be understood that Pakistan has lost (due to silt/sedimentation in the last four decades) substantial reservoir capacity and already in the 1990s a major Dam should have been ready to recover this lost capacity. A replacement reservoir was part of the WAA of March 1991

TOR4. What influence is climate change having on the availability of surface & ground water resource in the short to medium range? What environmental issues will arise due to the climate change scenario? The ground water contamination due to over exploitation / depletion of this resource is serious. In Punjab arsenic is at alarming levels. The environmental impact be understood and remedies found.

TOR5. Since Pakistan has not built any large dam after Tarbela (1974) the Hydel potential is seriously underutilized. Of the +100,000MW hydroelectric potential (identified +60,158MW) only 7,000MW has been tapped since 1947. About 33,000MW is under study/ investigations. Ghazi Barotha was the first major run-of-river HPP project using Indus Main waters. Its peak output of 1,450MW for several months of the year is a major low cost energy source since the last ten years. Can Pakistan's economy develop based on predominantly imported energy? Can the entrepreneurs be involved in hydro projects? .

Reference ToR – 1

Today Pakistan faces crises of drinking water, irrigation water, hydroelectric energy, flood control reservoirs, environmental degradation to refer to the major water related issues but not essentially in that sequence. The nexus between water-food-energy is the major issue of the 21st century. Pakistan is an agricultural country and the upper-riparian at the outset blocked the flow of the three Eastern/ Punjab rivers (Ravi, Sutlej & Beas). Hydro Infrastructure/ replacement reservoirs/ link canals became crucial. The idea was to divert waters of the three Western rivers to keep parts of the Eastern rivers alive. Also there was subsistence agriculture as 84% rains are in summer (Kharif season). Therefore a mechanism had to be created for early winter, early & late summer. Storages became crucial. It is estimated that value addition per cub.m is at the present state of development around US 50 cents equivalent. The world average is USD 8. The Japanese and USA economies are reportedly close to USD 30 equivalent value addition. There have been 12 major floods since 1947. The World Bank said USD 10bn was the loss to the economy as a result of the 2010 floods. Our panel estimates that during the crucial 21 days from 28th July to 18 August some 40 MAF additional water was lost to the sea due to the deficient hydro infrastructure. At productivity estimate of USD 2bn per MAF that was a loss of USD 80 bn in addition to the flood damage. A potential blessing became a destructive force. A domestic lobby against dams surfaced 40 years ago. Flood control & cheap/abundant electrical energy needs several more reservoirs. We have just one reservoir on the Indus Main & one on the Jhelum. As a consequence the GW abstractions at +40MAF are too high.

There was a consensus that the replacement value of the Irrigation assets including the IBIS and the WAPDA assets (dams + barrages) is close to USD 1tr. Asset is unleveraged and available for financing of mega storages, hydel generation and related infrastructure. There was a consensus that the drinking water quality due to over mining/ over exploitation of the ground water (GW) resource has resulted in it becoming seriously contaminated. Only surface water (SW) storages & flows can result in aquifer recharge. The rains below the Potohar are inadequate. Paved cities also inhibit recharge. The 40MAF GW pumped in Punjab is partly irreplaceable.

Reference ToR – 2

Due to our callousness we have since 1952 consistently suffered serious reverses on the hydro front. In 2008 India violated the basic tenets of IWT-1960 at Baglihar-I (450MW). The Neutral Expert had not been technically confronted by the Pak team with researched arguments. He gave a decision based on new technology & "state of the art" practice. Low level gates as “state of the art” silt excluders may have been technically a superior solution but are absolutely against the basic tenets of the IWT 1960 which in essence "limits live storage". The Indians may not divert IHK waters at will. Let the Indians accept the new science of environment & ecology established formally as Helsinki Rules 1966. The IWT 1960 came earlier. They must allow fresh water flows to Ravi & Sutlej for the ecological factors unknown in 1960. In line with the mantra of “state of the art” and human rights both nations should have equal rights on the water resource. In the Feb 2013 Kishenganga HEP(KG) decision the PCA did observe that any future dam in IHK may not use low level orifices/ sluice gates similar to Baglihar-I. A residual advantage however Pakistan lost the main case as diversion at KG HEP was allowed.

The nation must grasp the essence & spirit of the IWT 1960. The fifth column has been deliberately misinterpreting this Treaty to the disadvantage of Pakistan. The preamble of the IWT 1960 (Article III) states that Pakistan shall receive for unrestricted use all those waters of the Western Rivers which India is under obligation to let flow……. A phrase “the then” used in Annex C, Annex D & Annex E which literally meant “in the future” has been misinterpreted to create the false pretext of a race between Indian & Pakistani projects. The proposed Strategic Commission (CIBSA) has to use all available technological tools to determine the real flows in IHK and the impact of glacier retreat & global warming. Recent dialogues are alarming due to Indian stone-walling.

Reference ToR – 3

Yes Pakistan can sustainably increase productivity of its land and water through improved water management. There is only one solution to recover the storage capacity lost to sand, silt & sediment since the 1970’s. Since dredging is prohibitively expensive, only new mega reservoirs can correct this situation. Let us understand the effect of +0.5mn tons/day (160mn tons/year) of sand, silt & sediment arriving in the Tarbela reservoir. Dams do not consume water however their capacity will reduce if sediment sluicing to downstream channels is not efficient or available. Pakistan has to aim for a 30% SW storage capacity as a national objective. Its present level of around 8% (11MAF) is unacceptable and constantly reducing. In storage days it is merely about 29 days. Colorado valley achieved 900 days storage. Egypt’s ASWAN dam (on the Nile) created more that 3.5 years storage with just one dam. We must realize that under Pak hydrologic conditions each MAF that can be stored & utilized is another +USD 2bn/year to the national economy. Higher value addition is possible when we have the Indus Cascade with new agriculture & infrastructure projects. Details in Chap-18 and Annexure-F..

Reference ToR – 4

Climate change is clearly resulting in glacier retreat and consequently higher surface flows since a few decades and perhaps will continue for a few more. Pakistan does not have the storages to capture this valuable resource. During the floods 2010 we have seen catastrophic results. Water a gift of God becomes a destructive force. In contrast the Indian NRL ongoing project (costing +USD 212bn) covering 31 Northern & Peninsular Rivers will create a huge belly of water to store the extra flows due to global warming **and also act as a cover for withdrawals of IHK waters.** NRL will supplement the Indian water needs for the next century. Pakistan has to act with great speed in building mega-storages to meet its growing needs & store the flood waters due to global warming. These additional flows are also lost to the sea in just about 100 days of the monsoon/ flood season.

This report objectively reviews the terrible wastewater dilemma and expects the nation to wakeup. Water treatment on a large scale is still insufficient to ensure clean drinking water to the inhabitants of Pakistan

including Sindh. Sindh traditionally took its drinking water from shallow seepage wells which in several districts have been inundated with flood waters. The lower Sindh province has unusable brackish GW aquifers and with seepage of all kinds including flood waters is also sweet water lost in these situations. Any water that will seep into brackish GW is lost/ wasted. Water-logging is again endemic and is destroying crop lands. Over exploitation of Punjab aquifers has been caused by apathy of Pak planners. Prevention is always better than cure. In fact excessive mining of GW resource has seriously damaged its water quality. Tests reveal widespread bacterial contamination & arsenic poisoning as we mine ever deeper Entrepreneurs should seize this opportunity. Together with water filtration, wastewater recycle/reuse is today an important avenue for our entrepreneurs.

Reference ToR – 5

Hydel from multi-purpose dams today cost PKR 1.54 per unit after amortization of debt compared to gas generation which is +PKR 7/8 (and will increase due to LNG imports) RFO/HFO is + PKR 16/17. Coal or nuclear is about +PKR 9/10. Diesel based thermals +PKR 22. Further delay in building a 2nd dam on the Indus may not be tolerated. Hydel projects especially dams provide flood protection & flood control. Pakistan does not have a feasible & viable alternate to the hydro-electric source. The cumulative Hydel potential of multipurpose mega-dams and run of river (ROR) hydels now are estimated at +80,000MW. New technologies and studies have shown that Bunji HPP (ROR) alone can sustain a power house of +7,000MW with a reasonable plant utilization factor. It is therefore part of The Great Indus Cascade (2015-2040) proposed in Chapter-16 and detailed in Annexure-F. Many high-head projects (300m to 800m head) have been studied in the Northern areas, AJK & KP with excellent results. With careful planning & execution it may still be possible to do an EPC / turnkey high head HPP in the cost range of USD 1.0 to 1.4mn/MW. Many could be peaking projects. These high head HPPs must be studied by entrepreneurs & corporate investors. They hold the key to Pakistan's energy future.

1. WATER ENDOWMENT: THE NATION FLYING BLIND

Suleman Najib Khan

PREAMBLE:

Water is critical to our economy and its use will continue to increase. Sweet Water extracted from rivers, streams, lakes and groundwater is the common resource for survival of life, irrigated agriculture, municipal, industrial water and logically should be a major factor in the energy mix as its hydro-electric component. Pakistan is one of the nine (9) countries on the planet which could generate +50% of their energy needs from the water resource.Pakistan's major assets & the industrial profile e.g. agro textiles is based on this natural endowment. Let our nation and the world understand why India annexed J&K. **For a historical perspective on the Indus Waters Treaty the reader is directed to the WRDC website: www.wrdc.com.pk. Note titled Indus Basin Treaty submitted to the President of Pakistan on 10th Sep 1960 by an intellectual-bureaucrat Mr. Mohammad Masud (Khaddarposh) was ignored just as advise of caution from the World Bank President, Mr. William B. Iliff.**

The IBIS being the biggest national asset with a replacement value today of over USD 700bn equivalent. WAPDA's dams & barrages are also a huge asset and operate in tandem with the provincial distribution infrastructure within & outside the IBIS.Part of a priceless hydraulic machine. It is therefore unacceptable that the nation whose major population is living in its arid, semi-desert zone should be so ignorant & callous. The political forces have clearly used this life sustaining resources to divide their electorates. The deadly politics of water. The Indian factor emerges at partition in 1947 and is escalating yet the Pakistan nation seems to be "flying blind". The hydro assets have been severely damaged through a water war of attrition launched by a relentless & cold-blooded upper-riparian neighbor who pursues its water war with a brutal one point agenda. The weakening of Pakistan's economy she knows will lead to the ultimate break-up of its Federation with other collateral damage. Hatred & a historical complex drives India. What drives our fifth column? Water shortages lead to direct attrition of Pakistan's Defense capability. Remember the frightening words of the Indian Army COAS circa 2003 "Every opposition to KBD is another nail in the coffin (sarcophagus) of Pakistan's Defense Capability".

The lessons of the Bangalore round-table (Feb 2014) reinforced perceptions of their strategic trajectory. **India is absolutely micro-managing our hydro assets.** Their "water aggression" becomes ever more pervasive; adirect result of our lack of control, our lack of understanding of the hydro endowment. Pathetic disinterest by the PCIW & our nation. Here is the point-wise commentary of why we are at this low point and how we can reverse some of the damage and get a grip on the situation:

1.1 The major milestones in the Indian water campaign with its different perspectives.

i) The first strike was capture of the valley of Jammu & Kashmir in defiance of the agreed formula for the partition of British India. We see that in +68 years she has developed the capability to absolutely control the seasonal flow of the Chenab River, hide the additional flows in all three IHK rivers (Indus-Main, Jhelum, Chenab) resulting from global warming/glacier retreat. She creates infrastructure projects with storages & even low level gates all against the letter & spirit of the IWT 1960. Her projects in IHK have been surreptitious; part of her military campaign. Occupation of J&K was a strategic water-related act. Father of the nation had warned us by his quote "they have cut your jugular vein……..& beware of the fifth column....."

ii) Secondly India's calculated interruptions of our Eastern rivers share started in 1948. She used historically 6 MAF. The pressure applied was so consistent that she managed against all norms of civilized behavior to take 100% flow (33 MAF) of all three Eastern rivers (Ravi, Beas & Sutlej) under the IWT 1960. Last minute amendments for additional Western river waters

were also managed by India in the IWT 1960 under deceptive pretence. Far beyond the requirements of IHK population's local needs for drinking water, irrigation and forestry.

iii) The third strike after the 1971 war that created Bangladesh was to block (through her Pakistan agents) the construction of KBD. The IBRD/World Bank also conducted the ISO-14000 Environmental Studies in 1987 & fully cleared KBD project but the internal lobbyists in NWFP became ever more aggressive and an anti-dam/ KBD lobby emerged also in Sindh province. The province that had negligible sweet water aquifers began to oppose storage of sweet water during the three monsoon months. The elusive pursuit of a "national consensus" where the scientific facts are shouted down by political expediency isnow apparent. **Their objective remains clear. Destroy Pakistan's social order & harmony with chaos & anarchy.**

iv) The fourth strike in tandem with the multi-lateral agencies was to impose the concept of imported energy based electricity generation. The country's national utility was forbidden to build its own thermal stations. A major private sector initiative based on imported oil in 1988 from UK was given an exclusive mandate in 1992. An imported energy policy in the IPP domain followed in 1994. A balance between the public and private sectors would have seen healthy competition. Today the Hydel:Thermal ratio is lop-sided at 25:75 instead 70:30 which was a national priority. Thermal element in the energy-mix was always unavoidable due to the high variations of our surface flows. In 2012-13 Pakistan imported 24 mn tons of petroleum products worth USD 18 bn of which 13 mn tons was furnace oil (RFO/HFO) worth nearly USD 10 bn. This financial year RFO/HFO imports will be higher. Imported coal & LNG will provide some relief. Pakistan crossed +120 bn units of electricenergy. The unsustainable "Circular Debt" is before us but we lose + USD 60 bn annually due to neglect of our water resource.

v) The fifth successful strike was in 2001 when WAPDA was convinced to put KBD at low priority in its Hydro Vision 2025. It is said that Senator Nisar Memon & his "Indus Forum" activities were also behind the anti-KBD movement that became apparent in 2001.It was 2003 when the Indians were openly canvassing with multi-laterals against our proposed hydro projects & large dams in the Northern Areas. They also maneuvered an affirmation by Gen Musharraf that Northern Areas of Pakistan are part of "Greater Kashmir". This was like saying that Peshawar, Kohat & Jalalabad are part of Punjab because Ranjit Singh held administrative sway over them in the 19th century.To further sideline KBD the DBD height was increased dangerously. In the process DBDalso becomes too expensive to construct within WAPDA's balance-sheet.

Note: India's interference does not stop at Diamer Basha Dam. She also interferes in the planning of Pakistan's hydroelectric run of the river mega projects such as Bunji HPP (5,600MW / 20,000 GWh or 7,200MW / 24,000 GWh). Surprisingly the time for construction is now shown as +15 years for both DBD & Bunji respectively. A clear case of Indian interference through the multilaterals. India's ICID now ensures that IBRD/WB may not finance infrastructure projects in Northern Areas under its"Greater Kashmir" policy. Since WAPDA's balance sheet has been weakened by design the funding of mega projects is beyond its capability if the multi-lateral agencies are not supportive.India by 2001 accelerates the building of dams & HPP infrastructure in IHK.**In 2010/ early 2011 one Mr. Kamal Majidullah, a journalist from Sindh appears on the scene heading an NGO named Pak Trans Water Organization (PATWO). He was handed over control of PCIW; under the umbrella of PATWO on 23 Sep 2011**. He was leading a team created (by him) to contest the arbitration of Kishenganga HPP contested between India & Pakistan at The Hague. The decisions of the PCA dated 18 Feb 2013 & 20 Dec 2013 are available at Annexure-E. No doubt the defeat at The Hague is not less serious than the Baglihar-I decision of Neutral Expert (NE) six years earlier. A clear illustration why CIBSA (Annexure-C) becomes our over-riding imperative in addition to the rejuvenation of PCIW & WAPDA. We must stop flying blind under all circumstances.

1.2 Let Pakistan put its house in order

The full impact of the Indus Waters Treaty 1960 and loss of the three eastern rivers to India is not understood. The Indians are very well organized administratively & technologically through ICID and the Indian Water Commission under the Indian Commissioner for Indus Waters (ICIW). The technical support from WAPDA to PCIW was discontinued in the 1980s. Availability of data from IHK is virtually non-existent. A strategic organization on proposed lines as CIBSA is imperative. Internal issues under IRSA need wisdom & sincerity. The organization may have initially the following key responsibilities says Mr. Ch Mazhar Ali a former Chief Engineer and later an Adviser to the Punjab Irrigation Ministry.:

i) Collect and compile historical record of Indus Waters Treaty (IWT) negotiations, correspondence, aide memoires and stage developments.

ii) Examine the Treaty provisions. India is not sympathetic to Pakistan highlighting experience of Indian departures & aggressive actions. They define it as “interference”.

iii) Essential information including satellite imagery & Metrological data. ICIW had agreed to exchange of data on a daily basis (transmitted once a month)

iv) Indian plans to integrate their river systems under “Prabhu Plan” (NRL) be fully understood.

v) Analyze the history and experience of:

   a) Wullar Barrage on the Jhelum

   b) Indian Hydroelectric Projects on the Chenab at Salal, Dulhasti and Baglihar, specifically the steady encroachments by India of Treaty safeguards to Pakistan. The Indian capability to manipulate surface waters to create crisis situations. The Pakistan experience of Neutral Expert on Baglihar-I Dam.

vi) Theexisting and future planned Indian River Hydroelectric Projects on the Chenab and their likely adverse consequences for Pakistan and for Punjab agriculture in particular.

vii) The measures Pakistan may essentially take to mitigate the adverse impact of Indian mal operation of their increasing storage capabilities on Western rivers.

viii) By focusing on its Hydro Resource Pakistan can hope to again achieve the hydel:thermal ratio of 70:30. The nation needs to understand that the present lopsided ratio 25:75 is unsustainable and a recipe for bankruptcy. While over USD 60bn annual loss due to the water resource (Irrigation & Energy) is calculated the nation has in tandem inflicted itself to an imported oil liability of + USD 12bn annually after 1994.

ix) Opposition to the KBD project also deprives KP& Baluchistan of their rightful share of the Indus Basin Waters. The WATER APPORTIONMENT ACCORD 1991 becomes applicable once new reservoirs are built beyond what was existing in 1991. While conservation in irrigation methods is overdue the age old concept of Salaba (flood) Irrigation in the Sind province will have to be discarded through a province wide educational campaign. Salaba irrigation is a wasteful & inefficient utilization of precious hydro resource.

x) The concept of CBM (Confidence Building Measures) by Pakistan in contrast to Indian aggressive approachbe highlighted. Is she willing to let neutral experts of World Bank & other agencies to monitor the inflows into all her infrastructure projects in Held Kashmir?

1.3 Pakistan is an arid semi desert country

No doubt Pakistan has high mountain ranges crossing into its northern zone and it is said that Pakistan has five of the seven largest glaciers in the world including those in the Karakoram range& projections of the Himalayan & Hindu Kush ranges, Pakistan's economic survival is heavily dependent on surface waters. Basically its main rivers rise in Tibet, Kashmir & Afghanistan. More than half of Pakistan receives less than 10 inches of annual rainfall. As a result over 80% of agriculture is based on manmade irrigation systems & as a result over 92% agricultural output is from these irrigated lands. Since many centuries irrigation canals were used in the Indus Basin as rivers swelled in summers due to snow melt in tandem with the prolific monsoon rains. This monsoon event stretches over the entire country except the upper half of the northern zone and is of low intensity in the southern provinces of Sind & Baluchistan. We note a westerly shift in the monsoon since 2010. There is definitely more water but Pakistan is unable to profitas it lacks the essential infrastructure; the dams/ reservoirs.

The world's largest contiguous manmade irrigation system was built during the British rule of undivided India. The Indus Basin Irrigation System (IBIS) is confined primarily to the Indus plains through which flows the main Indus river and its major tributaries; Jhelum, Chenab, Ravi, Sutlej & Beas. The last three were snatched by India under the Indus Water's Treaty 1960. Pakistan had already started constructing river links between these Indus Basin Rivers due to Indian water aggression which commenced in 1948. The MR, the BRB, the BS link canals were constructed to transfer surplus summer waters from Chenab to Sutlej through the Ravi. Due to the IWT 1960 eight more were constructed including the CJ & TP link canals. Barrage controlled link canals was a workable idea as long as new storages could be created.

A vast aquifer below the Indus plains also exists duly recharged by precipitation, the river flows & from the seepage of the canal systems and their distributaries/water courses. The annual surface flows were by 1970 in the region of 145MAF while the ground water potential remained around 40MAF. The IWT 1960 had given the entire 33MAF annual flow of the three eastern rivers to India and therefore deprived Pakistan of some 27MAF of its historic share. One does not need to be an Einstein or a Newton to realize that Pakistan has a water based economy. The water weapon has been used by its adversary since its creation. The seizure of Jammu & Kashmir was a vicious & calculated first strike.

1.4 Construction of Dams on Kabul river

After restricting the flow of waters in the Indus, Jhelum and Chenab rivers by building hydropower projects on these rivers, India seems poised to intensify the water war against Pakistan with a plan to build 12 hydropower projects on the Kabul River in Afghanistan. Indian experts are extending help to Afghanistan to build 12 dams on the Kabul River with a total water storage capacity of 4.7 MAF; more than that of Mangla Dam. According to documents available, the government of Afghanistan is initiating multi-purpose water projects on the tributaries of the Kabul River with assistance from the international community. India plans to assist Afghanistan in this initiative, which will adversely impact Pakistan. The documents also show that the World Bank will provide funding for the 12 dams that will cost $7.079 Bn. Meanwhile US authorities have also offered their services to facilitate a water treaty between Pakistan and Afghanistan to ward off a future water dispute between the two countries. According to documents, four hydropower projects will be constructed in Punjshir sub-basin. These include the $332 million Totumdara project which will generate 200 MW of electricity and have water storage capacity of 332,510 acre-feet; the $1.174b Barak project which will generate 100 MW of electricity and store 429,830 acre-feet of water; $ 1.078 billion Panjshir (100 MW) project with the capacity to store 1,054,300 acre-feet of water; and the $607 million Baghdara (210 MW) project with the capacity to store 324,400 acre-feet of water. In the Logur Upper Kabul sub-basin on the Kabul River four more dams are to be built which include the $72 million Haijana project (72 MW) with water storage capacity of 178,420 acre-feet; $207 million Kajab (15 MW) project with water storage capacity of 324400 acre-feet; the $356 million Tangi Wadag (56 MW) project with capacity to store 283,850 acre-feet; and $51m Gat (86 MW)

project with water storage capacity of 405,500 acre-feet. Four more dams will be built in the Lower Kabul sub-basin, including the $442 million Sarobi project (210 MW) with the capacity to store 324,400 acre-feet of water; the $1.434 billion Laghman project (1251 MW) with storage capacity of 233,568 acres feet; and the $1.094 billion Konar (A) (94.8 MW) and Kama projects (11.5 MW). Pakistan and Afghanistan currently share nine rivers with annual flows of about 18.3 million acre-feet (MAF) of which Kabul River accounts for 16.5 MAF, while River Chitral, which originates from Pakistan, contributes about 8.5 MAF to it. After it enters Afghanistan this river is called River Kunar. It joins the Kabul River near Jalalabad and then re-enters Pakistan. We need to draw immediate attention towards the Indian plan and address the issue with the help of neutral experts. According to the details, "Ninety percent of Afghanistan's land area is located in the five river basins namely: Panj-Amu Darya River Basin, Northern River Basin, Harirud-Murghab Basin, Helmand River Basin and Kabul River Basin.The total storage capacity of these dams is around 4.7 MAF, which is more than that of Mangla Dam. It is further estimated that the planned dams will utilize 0.5 MAF water to irrigate additional 14,000 acres of land. Afghanistan has the right to utilize water from the Kabul River. In the absence of new major dams in Pakistan, it is feared that Pakistan will have to buy electricity from Afghanistan, which is the underlying purpose of the above mentioned plan of the Afghan Government in collaboration with India.

1.4.1 Way Forward

a. Study the impact in quantitative terms on the IBIS. The issue needs to be resolved at priority.

b. Direct negotiation with Afghan Government through the assistance of US / other friendly country or any other international institution preferably UN / World Bank.

c. Afghanistan should not be allowed to initiate in the first place before an agreement is in place.

d. Should encourage joint hydro-electric projects having little storage capacity.Projects should be need based and not a part of the Indian design to damage Pakistan's hydrology.

1.4.2 Report of Technical Committee of water resources. A non-starter meant to cloud the basic issue.

The summary pages of 2003-5 of this reportare available as an Appendix to Chapter-7.

1.5 IHK – 171 projects in 2010

i. In operation 42. Total installed capacity 2323 MW (13%)

Chenab	**Jhelum**	**Indus**
17	13	12

ii. Under construction 14. Installed capacity 1570 MW (9%)

Chenab	**Jhelum**	**Indus**
03	08	03

iii. Planning stage 115. Installed capacity 13,594 MW (78%)

Chenab	**Jhelum**	**Indus**
56	43	16

iv. Planning Stage Chenab: 56 projects (12,475 MW)
Construction of Pakal-Dal 1200MW & Sawalkot 1500MW has commenced in 2015.

v. Planning Stage Jhelum: 43 projects (845 MW)

vi. Planning Stage Indus: 16 projects (285 MW)

1.5.1 IWT 1960:

Dispute had started soon after the winding up of the Arbitral Tribunal on 31/03/1948. On 1st April 48 India stopped the flows in irrigation canals on rivers (Ravi & Sutlej) which were irrigating 1.6mn Acres in Pakistan. Direct negotiations had failed to resolve the dispute. Negotiations under the good offices of the World Bank / IBRD commenced in May 1952. IBRD (& the two countries) resolved to work out specific engineering measures by which the supplies effectively available to each country will be increased substantially. The IWT 1960 was signed after IBRD was convinced that the existing uses in Pakistan could not be met by transfer of flow waters from the Western Rivers and that storages on these Western Rivers were required for the purpose.

1.5.2 The perceived advantages to Pakistan were:

i) After completion of Indus Basin Replacement Works each country would become independent of the other in the operation of its supplies. “Unfortunately Pakistan was the lower riparian”. The acts of the upper-riparian are before the world to note.

ii) Each country is responsible for planning, constructing & administering its own projects and make its own allocations.

iii) This gives the incentive for each to make the most effective use of water. To improve efficiency & reduce losses in storages, transfer & operation.

iv) Before the completion of the Indus Basin project works (after signing of the IWT) the entire irrigation system in the Indus Basin was based on “run of the river” supplies. Since the hydrology of the rivers is that 80% of the total water were produced during the monsoon period (July-Sept) the winter supplies in drought period became critical.

v) Total canal withdrawals increased from 67 MAF to 104 MAF

1.5.3 The serious disadvantages to Pakistan were:

a) The traditional sailab (flood) irrigation on the three eastern rivers would disappear – it was a considerable area.

b) The loss of regular flow in the eastern river channels would silt-up the waterways & there would be subsequent havoc in case of floods.

c) The up-keep of the canals and new storages is a heavy burden. Besides storages have limited life due to sand, silt & sedimentation. They are unlike perennial rivers.

1.5.4 Did the IWT work for Pakistan?

It is a trap that India will continue to exploit being the Upper Riparian; as the “occupation” of IHK is now a 68 years old reality. Several manipulations in the Treaty were managed by India during 1952-60. Also:

a) The Indians do not provide the data required under the provisions of the Treaty.

b) "The Then" controversy.An absolutely ludicrous interpretation by the Indians.

1.6 Conclusion

Let us understand that the IWT 1960 is far more critical compared to the Water Apportionment Accord of 1991 as the later is an internal issue between the federating provinces. IRSA is basically our internal regulator created due to the WAA-1991. It is the Indian intervention influencing the surface flows into Pakistan that needs to be fully understood by experts in hydrology. Chenab inside IHK will be heavily manipulated;about 86% of its theoretical potential. Indian official strategy is to achieve +28,000MW installed hydroelectric capacity in IHK by 2020. Together with enlightened citizens & civil society the hydro truths must be removed from the political scene and taken to the scientific realm. The nation must understand all aspects of its hydrology, the water cycle, water conservation, water demand, water efficiency, wastewater recycle & reuse and water for the environment with all its manifestations.

What is the reason that potentially the richest nation of South Asia moves with a beggar's bowl? Let us analyze the financial & economic losses suffered due to the Indian Water Aggression since 1947:

The IBIS and the hydro infrastructure created before and after WAPDA was established is valued at over one trillion USD equivalent. The canal network as part of the IBIS is valued at +USD 700 Bn (replacement value). The 21 barrages are controlled by the provinces and/ or WAPDA. The medium dams are owned by the provinces or WAPDA. The large multi-purpose dams are owned by WAPDA.

When it is said that another dam or reservoir is going to be put up, it doesn't necessarily mean there will be additional water coming in; we are just re-appropriating what is already in the system and we waste. The country is moving towards the worst water shortage in the coming decade due to inadequate water management practices, insufficient storage capacity and Indian avarice for water. The annual surface flows will be around 145 MAF, the ground water abstraction below 45 MAF and rainfall 25 MAF.

The IBIS is therefore analogous to a hydraulic machine unable to perform optimally as it is water-short. **It is estimated that due to water shortages the financial & economic losses by 2014 had crossed one trillion USD equivalent.**The losses rose exponentially after 1999 when imported fuel costs quadrupled and continued to rise. The losses due to irrigated agriculture being higher since we could not go for triple cropping or bring additional farmland under cultivation. Inhibited by lack of hydraulic infrastructure and water shortages,soapparent after 1994.Potentially the richest nation in South Asia became dependent on handouts from the multi-laterals and was by nowaddicted to imported energy.

In Appendix & in Annexure C concept of CIBSA is explained. In Appendix F the Great Indus Cascade.

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Appendix

CIBSA: Commission for Indus Basin Strategic Analysis

There is no monitoring of IHK hydro sites which are no-go areas for all outsiders. Can three bureaucrats or technocrats sitting in the PCIW Secretariat take on thousands in the ICID? The creation of CIBSA is therefore overdue by atleast 55 years which is the age of the IWT 1960. Let our engineers, scientists & technicians come forward to serve CIBSA.

Let CIBSA finally educate the nation about the "hydro truths". Pakistan incidentally has now less than 8% of storage capability of its 145MAF annual surface flow. The role of sweet water is central to Pakistan's financial sustainability and survival. It is blessed with five of the seven largest glaciers on the planet. Pakistan Commissioner Indus Waters (PCIW) secretariat at Lahore deals with the cases related to the Indus Waters Treaty (IWT 1960). The commission works under the overall control of the Federal Ministry of Water & Power at Islamabad. While the Indus River System Authority (IRSA) also works directly under the Federal Ministry of Water & Power and manages the distribution of Indus Basin Waters to the provinces. The inter-provincial water disputes became manageable after the signing of the Water Apportionment Accord (WAA) in March 1991 and the creation of IRSA as a result in 1992. However both PCIW & IRSA lack the required punch due to deficient technical depth & commitment. In the case of PCIW secretariat it is shamefully under-equipped to face a diabolical, merciless & relentless upper riparian neighbor. PCIW must not depend on Indian data. If you look deeper the direct Indian factor again emerges. The Indian organization "International Commission for Irrigation & Drainage" established in 1950 has developed an "India First" agenda and through guile & cunning positioned itself in a position of great influence with multilateral institutions & government agencies worldwide. ICID is a dangerous weapon.The ICID now serves hundreds of international clients & even multi-lateral agencies. What is most relevant is that they have the tools to analyze accurately the hydrologic cycle of the Indus Basin. A detailed note on proposed CIBSA is presented in the Annexure-C) to this report.

In contrast PCIW has constantly stated that he has no data or information of the inflows in IHK rivers& streams. If the watershed in Kashmir is not understood how does Pakistan expect to neutralize the Indian strategy? Secondly every Indian move leading to attrition of water flows into Pakistan is blamed on the altar of "Global Warming". Yes glacier retreat is ongoing everywhere but this for the interim means more water in the rivers! This is clearly the rationale for the Northern River Linking project of India; a USD 212bn project launched in 2006 based on the famous Prabhu report of 1999. Let CIBSA help us understand that global warming & glacier retreat is a reality. Where is the expected increase in the inflow of Jhelum & Chenab? Nearly 40MAF additionally for the next 30 to 40 years were estimated. India will never disclose this bonanza although not available till eternity. They declared their intention to install +28,000MW of Hydel capability in IHK. The exact water diversion in IHK needs a deep analysis.

2. WATER SECURITY: NEW CHALLENGES (IN OUTLINE)

Sardar Muhammad Tariq

2.1 Irrigation System – History

- The Sub-Continent carries a long history of irrigated agriculture practiced by locals living along the water bodies including rivers, lakes, ponds, etc. and tapping seasonal inundations.
- Traditional irrigation practices changed into perennial irrigation in the 1880's through the advent of hydraulic structures and vertical pumps.
- Massive infrastructure enabled the land lying far away from water resources to be brought under perennial irrigation.
- Sub-Continent was converted into a region having one of the largest network of canals and hydraulic control structures creating it into a regional food basket.
- However, with the development of irrigated agriculture, water disputes also took birth among provinces.
- Committees/Commissions to address water distribution issues were constituted:
- Anderson Committee (1935). Indus (Rau) Commission (1939), Akhtar Hussain Committee (1968), Fazal-e-Akbar Committee (1970), Anwar-ul-Haq Commission (1981) and Haleem Committee (1983)

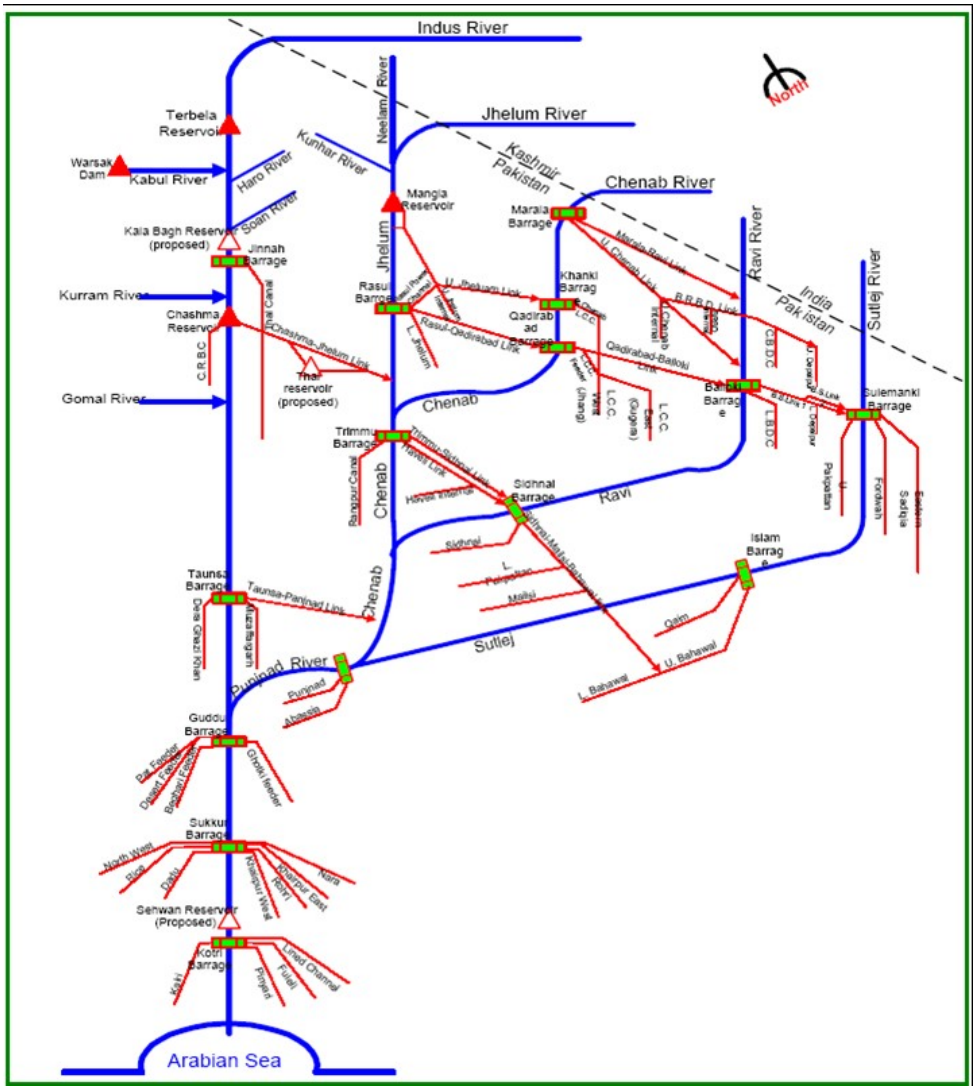
2.1.1 Mega Events in the Sub-Continent

- Sub-Continent was cut across during the partition in 1947 resulting into independent states of India and Pakistan with much of the control structures falling within India.
- India gained an upper hand as the upper-riparian and started exploiting the situation and stopped the river flows in 1948.
- Water Wars.
- The issue was resolved through the Indus Waters Treaty of 1960. World Bank being the Guarantor for the IWT 1960.
- Under this Treaty India was given exclusive water rights on the three eastern rivers namely Ravi, Sutlej and Beas whereas Pakistan was given uninterrupted use of the three western rivers (Indus, Jhelum and Chenab) with limited uses by India.

2.1.2 Irrigation challenges and Development

- Pakistan undertook the challenge and within a record period of ten years completed some of the mega irrigation structures thus converting Indus Basin into the world's largest contiguous irrigation system spread over some 18 Mha.
- Surface water system in the Basin is mostly weir controlled consisting three surface storage reservoirs (Tarbela, Mangla and Chashma), 19 barrages, 12 inter-river link canals, two siphons, 44 canal commands (23 in Punjab, 14 in Sindh, 5 in NWFP and 2 in Baluchistan), 62,300 km long irrigation canals i.e. 1½ time the circumference of the earth and 120,000 km of water courses.
- With this infrastructure in place, Pakistan developed extra-ordinary diversion capacity resulting in diverting close to 130 BCM of irrigation water annually.
- The infrastructure thus developed is extremely vulnerable to large floods.
- The infrastructure though massive, but still not capable of capturing the full surface water.
- Whereas 40% storage capacity is required against this only 7% is stored.

- Upto April 2013, 1,186 MAF of water has gone to the sea unutilized over the last 35 years which is equivalent to 12 years of canal withdrawals. In monitory terms, the value of unutilized water is US$ 174 billion after deducting 350 MAF required for environmental purposes. The financial impact is much greater as we may also calculate the value-addition of this resource.



Inter-Provincial Water Management

- There have been a number of occasions when the provinces showed mutual goodwill and accommodation in resolving long-standing disputes.
- Construction of Kotri, Taunsa and Guddu Barrages on the main Indus River after independence was the result of such goodwill and cooperation.
- However, there were many issues and critical areas which needed an inter-provincial mediation and harmonization steps to be taken by the Federal Government.
- In 1991, an Inter-Provincial Water Apportionment Accord was signed among the four provinces under arrangement by the Federal Government.

2.2 Inter-Provincial water management procedure

- Water Apportionment Accord 1991

Under the Inter-Provincial Water Apportionment Accord 1991, it was agreed to provide a total allocation of 55.94 MAF (68.97 BCM) to Punjab, 48.76 MAF (60.12 BCM) to Sindh, 5.78 MAF (7.13 BCM) to NWFP/KP and 3.87 MAF (4.79 BCM) to Baluchistan. Additionally, KP is entitled to 3.00 MAF (3.70 BCM) being used through ungauged (civil) canals above the rim stations.

- The Water Accord also lays down the distribution of the balance river supplies, including flood supplies as well as the future storages as 37 per cent each to Punjab and Sindh, 14 per cent to KP and 12 per cent to Baluchistan.
- The accord also emphasizes on development of future storages and recommends providing minimum flow downstream Kotri to protect biodiversity.

2.3 Role of Indus River System Authority (IRSA)

- IRSA was created in 1992 to manage water distribution (within Pakistan) in accordance with the Inter-Provincial Water Apportionment Accord of March 1991.
- IRSA consists of one member each from all the four Provinces of Pakistan and one from the Federal Government. Its decisions in case of any dispute are based on simple majority.
- Provinces place their indent on IRSA in accordance with their share and then distribute it among canal commands.
- IRSA plays major role in resolving inter-Provincial water disputes.
- IRSA is responsible to operate telemetric network to obtain real time flows data.
- IRSA assesses the season wise water availability for distribution among provinces.
- IRSA also keeps a close liaison with WAPDA and Pak Meteorological Department.

2.4 Why Indus Waters Treaty (IWT)?

- Contentious issues of water sharing rose immediately after the partition of the Sub Continent.
- The Partition line cut across the irrigation network of the Sub-Continent with control structures falling within India territory.
- In 1948 India stopped the water of the three eastern rivers.
- Water wars between the two sovereign states became imminent.
- World Bank intervenes in 1951 resulting in prolonged negotiation processes.
- IWT signed in 1960 after prolonged negotiations moderated by the World Bank..

2.4.1 Process of Negotiations

- Proposal by David Lilienthal, Former Chairman of the TVA, 1952.
- Single integrated basin authority to operate, maintain and distribute the Indus Waters between India and Pakistan.
- Both India and Pakistan straight away rejected the Proposal.

2.4.2 World Bank's Final Proposal

India's Proposal	Eastern Rivers	Western Rivers
To India	100%	7%
To Pakistan	0%	93%

Both India and Pakistan accepted it.

2.4.3 Pakistan's Concerns

- Water sharing formula recommended by the World Bank and accepted by Pakistan was not the ideal.Pakistan got 75% of the Indus Waters against 90% of the irrigated land – according to International Law Commission it tantamount to violation of the principle of "Appreciable harm".
- The IWT divides the rivers of the Basin – with three eastern rivers given to India, Pakistan loses the lower riparian rights.
- Maintaining the river health and biodiversity, the minimum environmental flow is being denied.Prior to IWT, India was utilizing only 3 MAF (4 BCM) of eastern rivers flows but got 33 MAF (41 BCM) under the Treaty.
- India got 30 MAF (37 BCM) additional water for future development, Pakistan got nil.
- India has multiple basins for inter-basins transfer opportunities, Pakistan depends on single basin (Indus Basin) with no additional water.
- Pakistan considers the historic uses allowed to India on the western rivers restricted to small interventions of local communities living along the river banks and not for constructing mega hydropower projects and putting them on national grids.

2.4.4 Issues and Challenges Created by IWT for Pakistan

- Irrigated area in the east and water in the west.
- Over 3 Mha of most productive land of Pakistan in West Punjab denied water of the three eastern rivers.
- Pakistan was compelled to undertake world largest civil engineering works to transfer water through canals, headworks and barrages from western rivers to irrigated land in the east.
- The hydraulic infrastructure development under the Treaty resulted in huge O&M challenges and heavy O&M annual cost.
- Infrastructure resulted in high degree of safety hazards under exceptional floods.
- Sediments flourishing delta were trapped in canals and headworks resulting in millions of hectares of land in the coastal belt becoming non-productive with severe salt intrusion.
- Thousands of villages in the coastal region had to be abandoned.
- The Treaty resulted in denial of environmental flows in the three eastern rivers as they enter Pakistan affecting river health and biodiversity.
- The inter-river canal network resulted in twin menace of water logging and salinity.
- With 41 BCM of eastern rivers water given to India, the per capita availability of water declined sharply in Pakistan.

2.4.5 Additional Challenges for Pakistan

- Climate change impacts on Glaciers –climate models indicate melting of glaciers – 30 to 40% reduction expected in flows.
- Construction of large number of hydropower stations with storages by India could deny water during critical cropping period.
- Over extraction of groundwater in East Punjab due to highly subsidized electricity tariff by India can over mine the aquifer in West Punjab thus further depleting the water availability in the West Punjab.
- Untreated affluent both agricultural and industrial entering Pakistan from Indian side is degrading the land quality and contaminates the ground and surface water in Pakistan.
- **Perpetual decline in transboundary river flows. 12 BCM decrease in flow between 2000 to 2014.**

- With rapidly growing population, multi-sectoral demand of water is going to increase substantially resulting in myriad management and water governance issues and challenges.

2.4.6 Post-Treaty Water Management Approaches

- Pakistan within the ambit of issues and challenges is managing its water resources to meet its multi-sectoral demands.
- The IWT split the transboundary rivers and Pakistan with known share of waters entering into its territory is distributed according to Inter-Provincial Water Apportionment Accord 1991.
- Each Province therefore, knows its share of water and manages it as a Provincial subject.
- Indus River System Authority (IRSA) a Constitutional Entity is responsible to distribute the water among the provinces and also to resolve Inter-Provincial disputes.
- The problem that Pakistan faces is the water governance. There is no national water policy and no law exists on governance of ground water.
- Water thefts, inequitable distribution and under pricing are the main outcomes of the poor management and lack of institutional capacity.
- The hydraulic infrastructure suffers from endemic poor maintenance and scarcity of O&M funds which gets magnified due to malpractices and corruption.
- Water rights and entitlements are violated by more influential segment of the society.

2.4.7 Transboundary water disputes – resolution mechanism

- Under the Indus Waters Treaty 1960 restrictions have been placed on the design, initial filling, operations of hydroelectric plants, storage works and other river works to be constructed by India on the Western Rivers.
- The Treaty provides a procedure for the settlement of the differences and disputes. Any question, which arises between the parties, is to be first examined by the Indus Waters Commission. If the Commission fails to resolve the issue, either Water Commissioner can initiate action to resolve the issue through Neutral Expert/Court of Arbitration.

2.4.8 Existing Water Disputes with India

- India's Wular Barrage and Tulbul Hydropower Project on river Jhelum is in clear violation of the Treaty.
- Storages on western rivers beyond 12.30 MCM not allowed.
- Kishenganga Hydropower Project would affect Neelum Jhelum HPP of Pakistan.
- Court of Arbitration has partially supported Pakistan but allowed India the first right.
- Baglihar Dam-I(450MW)– Also effects the flow of Chenab river to the detriment of Pakistan. The Neutral Expert allowed India storage beyond the Treaty on pretext of flushing sediments.

2.5 Pakistan Water Vision 2025 – Objectives

- To prevent the water shortages in the future
- To compensate/adjust for the predicted climatic changes
- To protect the agriculture sector from droughts
- To increase reservoir capacities lost due to siltation and develop new storages to cater for future needs
- To develop 16,000 mw of hydropower for providing cheap electricity to consumers
- to invest US$ 33 billion in next 22 years to achieve the above vision

2.6 Critical Review of Water Vision 2025

- A generalized statement - has no relationship with the ground realities.
- Addition of 16,000 MW of power is not related to the demand pattern.
- Does not address inadequacies of the transmission system to transport additional power.
- Upgrading the overloaded and dilapidated transmission system would consume most of the budget allocated for undertaking overall Vision objectives.
- Vision does not talk about the load projections, demand growth and reserve capacities.
- Vision is completely silent about myriad water issues and challenges.
- **Dependent upon single basin and influx of about 144 MAF which has reduced from 154.88 MAF over the last 10 years without any valid reasons**.
- No consensus on National Water Policy.
- Heavy sedimentation in the reservoirs, rendering food security and energy security a real issue. It seems to have been absolutely ignored.
- India's Hegemonic attitude and violation of Indus Waters Treaty seriously affects transboundary river flows to the detriment of Pakistan.
- Hotspot for climate change impacts which would add additional variability in the hydrological pattern.

2.7 Water Security Strategy for Pakistan

Within the Country

- A consensus National Water Policy must be put in place immediately.
- The technical and management capacity of the institutions dealing with water at Federal and Provincial levels must be enhanced.
- Water governance and management issues must be addressed on priority basis.
- Additional storage reservoirs must be constructed to enhance storage per capita and carry over capacity.
- Rainwater harvesting – 40 MAF (49 BCM) per annum – we only utilize 20% of it – 10 mm/hectare is 100,000 liters – countries capture almost 98% of the rainfall.
- Water savings/conservation in all sub-sectors.
- Pollution control of fresh water bodies. A most serious matter also.
- Principle of **3Rs – Reduce – Recycle – Reuse** can save up to 40% of water.
- Wastage control.
- Desalinization.

2.7.1 Way Forward to Ensure Water Security in Pakistan

Transboundary

- Indus Waters Treaty must be followed in letter and spirit.
- The complexities of issues with India, lack of political wisdom and will, position based stands, high level of mistrust, linkages to Kashmiri issue, negative public perceptions and deep buried hostilities offer formidable obstacles to cross.
- Exchange of real time data between India and Pakistan is a prerequisite for better management of water resources – India needs to respond positively.
- India's Hydropower Projects numbering 33 on western rivers have adequate storage capacity to harm Pakistan's irrigated agriculture – on the other hand if India agrees to release water at the critical time of crop requirement it could benefit Pakistan tremendously.

- Environmental Flows- India's diversion of 100% flows of three eastern rivers during low flow season is highly detrimental to river biodiversity and recharge of groundwater. India must adhere to international environmental laws and restore minimum flow.
- Transboundary Aquifer Mining: With very low energy tariff in East Punjab, India is over mining the aquifer of West Punjab which is also against the international laws.
- Transboundary Pollution: Due to natural topography, the agricultural effluent and untreated industrial effluent both flow into West Punjab not only creating serious environmental issues but polluting our fresh water bodies and groundwater as well. Under international laws, the riparian states are required to ensure untreated effluent is not discharged which crosses over to lower riparian states. The four Indian drains are a terrible reality.
- Discussion on Indus Waters Treaty should be delinked from both historic grievances and from other Kashmir related issues, both sides showing a sign of statesmanship and moving forward considering water as catalyst for development and not a sourceof conflict.
- Similar to IWT, Pakistan needs to sign a treaty with Afghanistan to protect its historic water rights as lower riparian state.

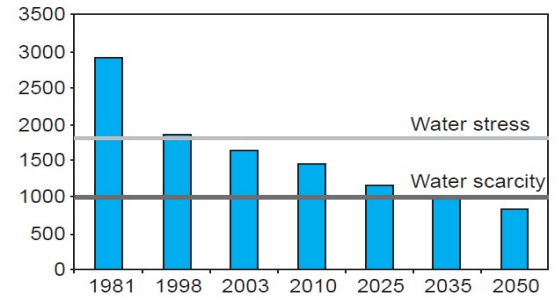
2.7.2 Climate Change& Conclusion

Climate change would have extreme detrimental impacts on water resources of Pakistan. Various models indicate that global warming can accelerate glacier melt and change the monsoon pattern and can result in water reduction to the tune of 30 to 40%.

Pakistan therefore needs to have both software and hardware solutions to meet its future water related challenges.

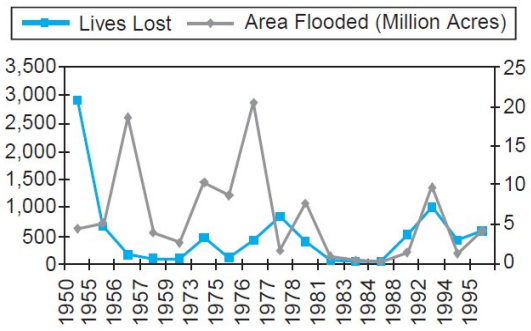
Appendix: Demographics & Flood losses etc

Fig. 2.2: Declining per capita availability of water in Pakistan (cubic meters per capita per year)



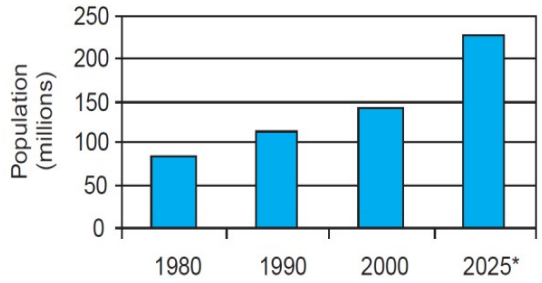
Source: Amir, 2005.

Fig. 2.5: Flood losses in Pakistan



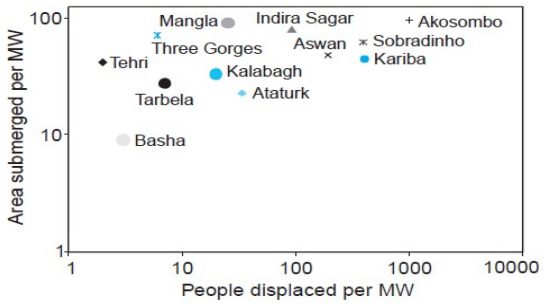
Source: Kazi, 2005.

Fig. 3.2: Population growth in Pakistan



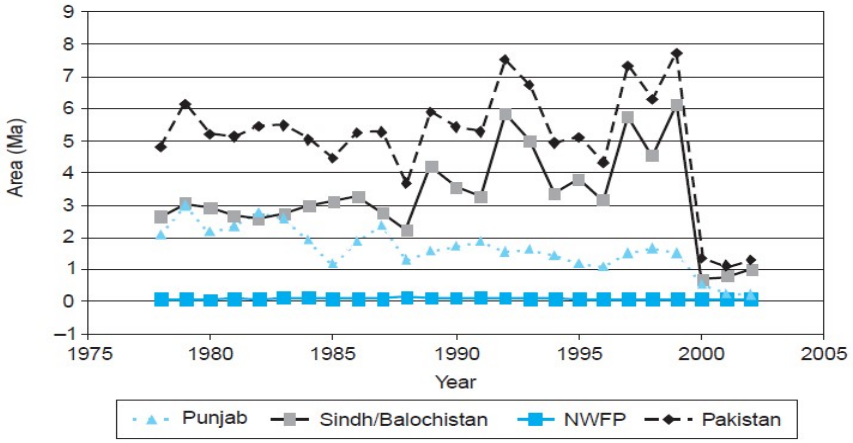
Source: Siegmann and Shezad, 2005.

Fig. 3.48: Partial environmental and social indicators for some multipurpose dams



Source: Ledec, 2003.

Fig. 3.31: Long-term trends in severe waterlogging



Source: Bhutta and Smedema, 2005.

Courtesy: "PAKISTAN'S Water Economy Running Dry" (John Briscoe • Usman Qamar)

3. GROUNDWATER OVER-RELIANCE: TRAGIC CONSEQUENCES

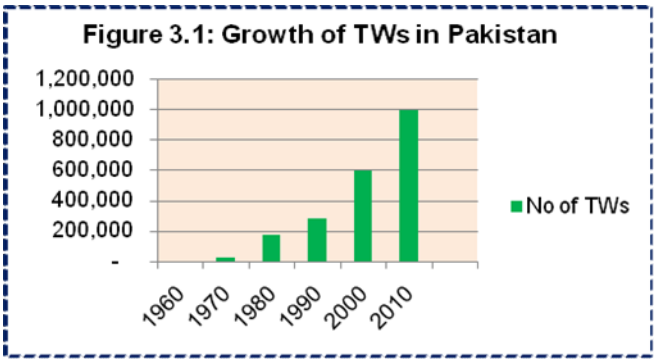
Muhammad Shamshad Gohar

3.1 Historic Background

Invaluable Contribution to National Growth: Water has played the major role in the economic development and sustainability since independence. Pakistan is, mainly, an agricultural country and its' economy, particularly in the rural areas, greatly depends on agriculture based activities. Agriculture involves 47 % of the workforce and contributes 25 % of GDP and 60 % of the export. As the country lies mostly in semi arid region – with annual rainfall about 10 inches and evaporation about 60 to 70 inches - dependable irrigation for production of food and fiber for around 190 Million people is but a sine qua non. Developed surface water resources (existing canal supplies on an average are around 105 MAF) and hence, groundwater has played the critical role for meeting the crop water requirements and provision of drinking both to urban and rural populations. There has been a tremendous groundwater development in the last 3 to 4 decades, due to dedication by the farmers, who presently operate around one million private tubewells (PTWs) in the country, mainly, for agriculture. Nearly 90 percent of the total groundwater abstraction - estimated around 50 – 60 BCM - is being used for agriculture. The investment on the PTWs may be of the order PKR 40-50 billion whereas the annual benefits in the form of agricultural production may be of the order of PKR 250 Billion. Population growth and increasing demand of water for irrigation, water supply, industry and environmental needs would further boost its importance in the future.

Government Policies and Investment Programs: At the time of independence, groundwater use in the country was very limited - mainly through Persian Wheel Wells and Karezes in Balochistan. On the other hand large tracts of agricultural lands - around 4 million ha - in the Indus Basin were threatened with the twin menace of water logging and salinity, which had resulted from the seepage from the irrigation system during the last 70-80 years. GOP started a program of salinity control and reclamation projects (SCARP) in 1960s and gradually installed 15,000 high capacity tubewells (56 to 140 l/s) – in the Punjab, Sindh and NWFP - mainly to lower the high water tables. More than 80 % of these tubewells were located in the fresh groundwater areas. SCARP tubewells (STWs) greatly helped in the lowering of water table below the root zone and reclamation of the effected lands, which were originally very fertile. Farmers - enchanted with the initial success of STWs in lowering and controlling the water table on one hand and the availability of the additional water to increase their cropping intensity on the other – started installing their own private tubewells (PTWs). Advantage of a tubewell in supplying the timely irrigation provided them a psychological cushion to plan the type of crop and the intensity.

Due to the limited availability of surface water the farmers – the farmers kept on installing their tubewells. Advantage of a tubewell in supplying the timely irrigation provided them a psychological cushion to plan the type of crop and the intensity. Slowly the PTWs kept on increasing in number and there has been a tremendous groundwater development in the last 4 decades bringing the population of PTWs from about 4,000 in 1960 to around 1000,000 (as shown in the Figure 3.1).



Uncontrolled Pumping & Dwindling Groundwater Regime: In 1960 groundwater accounted for only 8% of the farm gate water supplies in Pakistan's most populous Punjab Province, but 25 years later this had gone up to 40%. At present the groundwater use for agriculture accounts for more than 60 % of the water at the farm gate. Well illustrated when the country produced 20 million tons of wheat during the year 2000 – a drought year. Similarly, the drinking water requirements gradually increased and as the larger part of the population - about 190 million persons – depends upon groundwater sources - the pumping requirements and also the number of tubewells kept on increasing; resulting in intensive pumping in areas like Lahore, Quetta, Faisalabad, etc. The aquifers are already under stress due to Intensive and uncontrolled pumping of around 50 BCM in various parts of the country. During the recent drought large areas - almost all over the country – showed water level declines of 2 to 3 meters. Worst hit areas were the parts of Quetta –Pishin in Balochistan, Tharparker in Sindh and Pothwar Plateau and Cholistan Desert in the Punjab where large numbers of wells went dry or saline.

3.2 General Scenario on Water Availability

3.2.1 General Picture of Land & Water Resources

Pakistan is - pragmatically speaking – an arid country with its economy based on the single river – Indus. It is naturally an environment of extremes, with large seasonal and annual variations. About 70% of the flow in the upper Indus occurs in just 3 months of the year. Deserts with rivers flowing through them have long attracted civilizations because they offer huge opportunities for prosperity if the extremes of river flows can be managed. Land and water resources of Pakistan are as shown in the Table 3.1, given below:

Table 3.1 Pakistan's Land & Water Resources

Parameters	Punjab	Sindh	NWFP	Balochistan	Pakistan
Land Resources					
Total Area (MA)	51	35	25	86	197
Cultivable (MA)	30.31	13.96	4.54	5.21	54.02
Canal irrigated -GCA (MA)	24.62	14.12	1.45	1.00	41.19
Canal irrigated -CCA (MA)	21.30	12.00	1.10	0.81	35.21
Barani (MA)	9.01	1.96	3.44	4.40	18.81
Water Resources					
Canal Supplies (avg - MAF)	53.82	45.28	3.58	1.76	104.44
Groundwater Potential (MAF)	40.00	10.00	2.40	0.90	53.30
Groundwater Use (MAF)	34.00	3.50	2.00	0.50	40.00
Tubewells (Number – Apx.)	880,000	50,000	30,000	40,000	1000,000

The annual rainfall ranges from about 60 inches in the north to less than 5inches in the south – with an average of around 10 inches – whereas the annual evaporation ranges from 60 inches to more than 100 inches per year. It is also to be considered that about 80% of the rainfall occurs during the monsoon period. This naturally calls for adequate storage facilities.

The sustainability of the food and fiber for the 190 million (population continuously on increase), we do need an adequate and dependable system of irrigation and storage. Our existing surface water supplies are based on a total diversion of about 104 MAF – of which less than 50 % is available at the farm gate to farmers. This is grossly inadequate for irrigating around 40 Million acres of cultivable lands. This leads to the basic requirement of large storage reservoirs which can also help in the production of clean and cheap electricity for the growing industrial sector – which is also on the brink of collapse due to shortage of energy supplies – now mainly dependent upon the thermal power stations – in a country importing more than 80% of oil.

During the last 30-40 years - a great stress has been laid on the groundwater regime – all over the country. The fact that we have a large groundwater reservoir - the Indus Plain – does not mean that we can go on pumping groundwater without any regulatory management or any consideration to the average annual recharge – which is mainly from the irrigation system – more than 80 %. Accordingly the long-term availability of groundwater is directly linked to the flows in the rivers and canals. A brief account of the existing situation – related to water availability and pot ability - water safe for drinking and even irrigation, industry and some for protection of ecosystem is discussed below.

3.2.2 Groundwater Potential and Use

Based on the studies by WAPDA and other public and private agencies – general picture of the groundwater potential and existing use in each province is given below.

PUNJAB PROVINCE: The Punjab is underlain by different types of geological formations ranging from the hilly plateaus and gullies in Pothwar Plateau to the alluvial plain in the central part of Punjab, with more or less desert conditions in Thal and the Cholistan Desert. For groundwater assessment the Province can be divided into four hydro-geological zones as under:

- Pothwar Plateau & Salt Range comprising a number of inter-mountain valleys and basins;
- Piedmont Areas along Suleiman Range;
- Alluvial Plains of Central Punjab comprising active and abandoned flood plains along the rivers and Bar uplands in the central parts; and
- Cholistan Desert in the south eastern part of the Province

Major sources of groundwater recharge are rainfall, seepage from irrigation system, rivers and return flow from groundwater use.

Groundwater quality is generally fresh along the rivers and saline in the central parts of the Doabs.

SINDH PROVINCE: The Sindh forms the southern part of the Indus Plain, which lies below Guddu, forming the narrowest width of Indus Plain below the confluence of Panjnad River with Indus and near the abrupt bend in the Suleiman Range. River Indus is the sole source of surface water for the Province of Sindh. About 41 percent area of the province is under irrigation through the canals off-taking from three Barrages in Sindh, namely Guddu, Sukkur and Kotri. Irrigation supplies to Sindh Province are around 56 BCM (45 MAF). The climate of Sindh is hot and arid. Average annual rainfall is within 265 mm (10.4 inches). The maximum temperature in summer exceeds 40^{o} C (104^{o} F). The Province can be divided into three climatic zones:

- Coastal, south of Thatta and including Karachi –203 to 254 mm rainfall;
- Southern, from Thatta to Hyderabad to Nawabshah – 125 to 250 mm rainfall; and

- Northern from Nawabshah to Jacobabad – 75 to 125 mm rainfall.

Annual lake evaporation varies from 1524 to 2160 mm (60 to 85 inches) in the irrigated areas and generally exceeds 2286 mm (90 inches) in the adjoining desert areas.

Groundwater quality in Sindh is generally fresh and useable (within 1500 PPM) along the Indus and in the irrigated area and deteriorates away from the river. The native groundwater of the Lower Indus Plain is highly saline being of marine origin. In the piedmont belt along the slopes of the mountain ranges the groundwater quality is generally poor with pockets of useable water. The deltaic area south of Hyderabad is saline water area, except in some shallow pockets in the abandoned riverbeds of Gaja area.

KP PROVINCE: The area of the Province is 10 M ha of which, 7.5 M ha are under provincial administration while the remainder cover the Federally Administered Tribal Areas (FATA). There is a wide variation in precipitation both in amount and distribution over the year. In the mountain in the north of Mansehra district the annual precipitation exceeds 1000 mm, while in the arid areas of north it is only 150 mm and in south Dera Ismail Khan it is less than 250 mm. Potential evapotranspiration is high in summer because of high temperatures and low relative humidity. It ranges from 850 mm (34 inches) in Swat District to 2000 mm (80 inches) in Dera Ismail Khan.

The quality of shallow groundwater in the valleys, which is largely derived from infiltration of rainfall and seepage from canals and fields, is generally good (less than 1500 PPM of dissolved salts). However, in Bannu Basin, the chemical content of the upper horizon ranges from 350 to 3000 PPM.

BALOCHISTAN PROVINCE: Balochistan Province comprises a series of inter-mountain valleys, generally trending northeast-southwest. A series of thrust faults run along the south-eastern flanks of the mountain ranges due to the subjugation of the Indian Shield by the Arabian Shield in the geologic past. The average annual rainfall varies from 50 mm in the west to about 400 mm in a small area in the north-east of the Province. The precipitation over a larger part of the Province is about 100 mm per year. On the basis of isohyetal contours, three distinct regions can be identified in Balochistan.

I) Quetta – Zhob region receiving rainfall of more than 200 mm

II) Turbat – Kharan – Sibi region receiving rainfall of 100 – 200 mm

III) Chaghai region receiving rainfall of less than 100 mm

The regions of the Province, which are underlain by unconsolidated sediments, formed by the deposition of mountainous outwash from the surrounding highlands, have been divided into **12 distinct Basins**, flood plains and valley fills. The following five hydro-geological zones can be recognized in the Province:

I. Mountain Ranges

II. Piedmont Plains

III. Valley Floor and Basin Plains

IV. Playas

V. Rolling Sand Plains (Sand dunes/deserts)

3.2.3 Groundwater Budgets under Normal Climatic Conditions

Groundwater budgets for the provinces - under normal rainfall conditions and water use - are shown in the Table-2 given below:

Table 3-2: Groundwater Budgets under Normal Rainfall Conditions (BCM)

Recharge Components	Punjab	Sindh	KP	Balochistan
Rainfall recharge @ 5 - 10 %	8.02	2.42	1.08	1.49
Recharge from irrigation system 30 – 40 %	26.65	18.92	2.28	0.82
Return flow from GW abstraction 15-20%	8.39	0.97	0.16	0.22
Recharge from the River System	1.36	0.37	0.32	0.10
Total	**44.42**	**22.68**	**3.84**	**2.63**
Discharge Components				
Groundwater abstraction	41.95	4.30	2.18	0.56
ET losses in high water table areas	2.47	16.96	0.30	1.39
Base Flow to Rivers	-	1.42	0.30	0.17
Sub-surface outflow			1.51	0.41
Total	**44.42**	**22.68**	**4.29**	**2.53**
Net Balance	**-**	**-**	**(0.45)**	**0.10**

Synopsis: These groundwater budgets – representing so called average conditions do not provide the true pictures of the prevailing field conditions in each province. As there are a large number of areas where the groundwater regime is under pressure - these areas include "Tail Reach areas of the canal system and areas around large cities such as Lahore and Quetta where the groundwater levels have been continuously declining forming cones of depressions.

Apart from this, the pumping from more than one million tubewells keeps on upsetting the water budgets – as farmers pump less groundwater in wet years (when the recharge is more) and more in the dry years whereas the groundwater recharge is less – resulting in over draft and declining water levels.

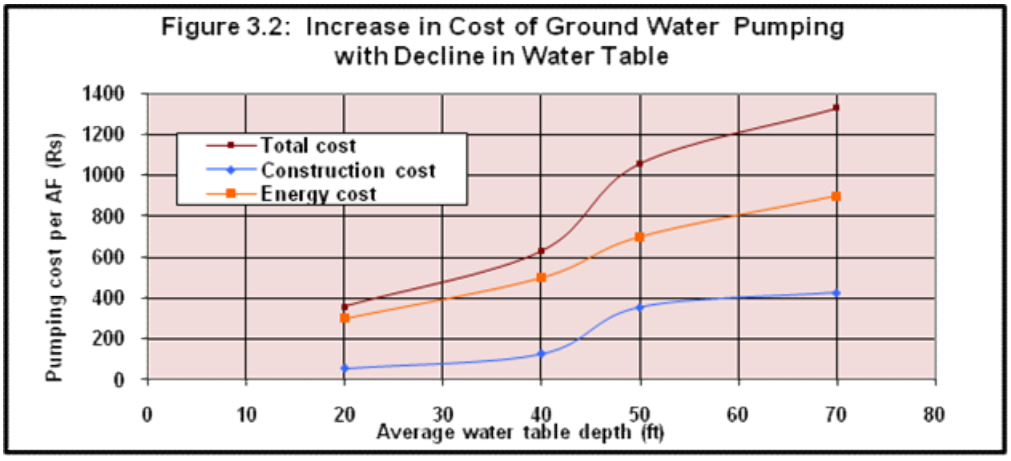
3.3 Existing Scenario

With the dramatic increase in intensity of groundwater exploitation over the last 3 – 4 decades however, the policy landscape has been changing. The main issues in groundwater management nowadays relate to environmental sustainability and welfare: how to avoid declining groundwater tables and deteriorating groundwater quality in fresh groundwater areas; and how to ensure equal access to this increasingly important natural resource.

Threats to Groundwater Resources in Pakistan: With the shifting of the role for groundwater development particularly, in the FGW areas from the public to private sector there is a need to watch the pace of groundwater development in various parts of the country to maintain a balance between the average annual groundwater recharge and discharge. The farmers pump groundwater in accordance with their crop water requirements without having any consideration of the drainage requirements or the quantum of groundwater recharge in their areas. This process results in less pumping during the wet years (drainage requirements may be more in such years) and more pumping in relatively dry years causing excessive draw down in certain areas. The unsystematic/unevenly distributed large scale pumping has given birth to a number of adverse interactions such as:

a) **Abnormal lowering of water table** in some of the areas is making the pumping more expensive, thus depriving poor farmers from using groundwater to supplement the canal water supplies. Even in FGW areas, the continuous lowering of water table will force the groundwater use out of the reach of some farmers due to increase in pumping cost. About 95 % of the farmers - particularly in Punjab and Sindh provinces -are using centrifugal pumps to draw water, which have limitation for water suction. The farmers have to construct a sump when the pumping water level is more than 20 feet deep. With gradual increase in water table depth, the farmers have to deepen their sumps and this is not only uneconomical but also hazardous at depths more than 50-60 feet. Below that depth, deep well turbine pump may have to be used as prime mover (PPSGDP 1997-2001). This may increase the cost from Rs 60,000 to around PKR 300,000 taking groundwater use out of the reach of small farmer. Similarly the pumping cost increase from around PKR 300 to more than PKR 600 per acre-foot of water as shown in Figure 3.2. These situations should be avoided by taking the necessary steps, at this stage, for appropriate management/regulation of the groundwater resources

Figure 3.2: Increase in Cost of Ground Water Pumping with Decline in Water Table



b) **Saline groundwater intrusion** in the areas adjacent to the SGW zones due to excessive pumpage in fresh groundwater areas.

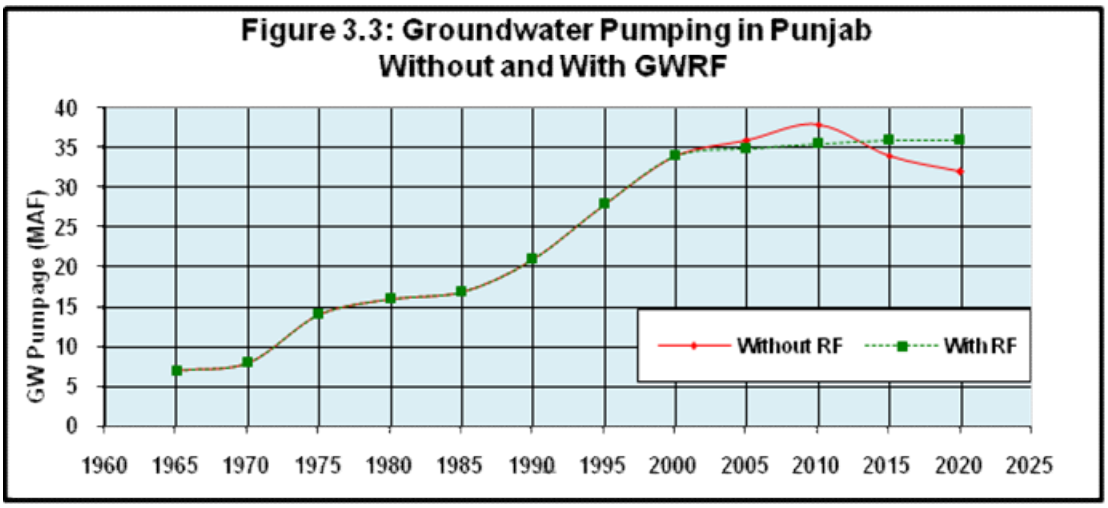
c) **Deterioration of groundwater quality** in the areas with shallow lens of FGW overlying SGW due to up coning of saline fresh water interface **and pollution of the aquifer - particularly at the shallow depth** - due to the unchecked discharge of industrial, sewerage and agricultural wastes and contaminants (use of fertilizers, pesticides, herbicides, etc.).

d) **Water logging and salinity** in the areas located along the major canals and/or in the physiographic depressions. Water logging has generally disappeared in large areas due to the recent drought conditions, but still needs attention – when looking at the land and water resource sustainability on long term basis.

3.4 Need of the Day

Recent studies by UNICEFF, PCRWR (in Punjab and Sindh)[1] and EPD Punjab[2] indicate that the pollutants in the form of chemical, bacterial and toxic contamination have already reached the groundwater regime – at least at the shallow depth which is, mainly, exploited by the private sector – both for drinking and agriculture. These interactions are likely to turn into a serious situation if proper attention is not given to arrest these trends. Without any appropriate measures the unchecked increase in groundwater development (particularly, in some Critical areas) will tend to be controlled with a "self regulation process" due to mining of the aquifer and/or gradual increase in the salinity – resulting in decrease of actual availability of useable groundwater. On the other hand, we can ensure a sustainable use through appropriate monitoring and management of the resource as shown in the Figure 3.3 given below[3]:

Figure 3.3: Groundwater Pumping in Punjab Without and With GWRF



In order to address to these problems regulatory framework for groundwater management and regulation is required. In order to administer these regulations an effective institutional set-up is an essential requirement. Management and Regulation of the groundwater resources has to be done for its optimal utilization and long-term sustainability and to ensure its equitable access to all the users. Under the prevailing circumstances the excessive use in certain areas may result in mining of the aquifers and/or the deterioration of the groundwater quality whereas water logging still persists in some areas. This situation warrants appropriate measures for the management/regulation of groundwater to ensure its sustainability.

A brief account of the existing groundwater conditions, use, threats and the ways out in the various parts of the country are discussed in the succeeding sections.

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[1]Report on Groundwater Quality Monitoring in the 21 districts of the Punjab and Sindh by UNICEFF and PCRWR, 2003.

[2]Sub-Soil Water Quality Monitoring in 14 Districts of the Punjab, Provincial Task Force on Sub-oil Water, April 2003.

[3]Study carried out under Punjab Private Sector Groundwater Development Project, Go Punjab and WB, 1997-2001.

3.5 Groundwater Management Problems and Constraints

GW management problems can be attributed to physical, social, institutional and policy constrains – interacting & tied to each other. Major GW management problems in the country include the following aspects (box given below):

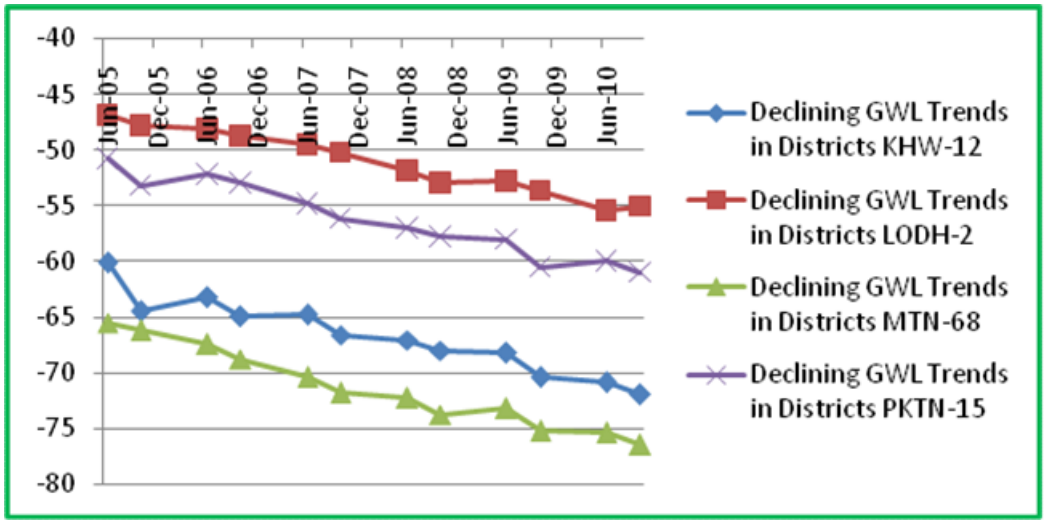
Groundwater Management Problems

- Groundwater depletion/overdraft and saline groundwater intrusion
- Groundwater pollution – due to discharge of uncontrolled effluents
- Non-availability of outfall for drains resulting in water logging and soil-salinity in some areas;
- Lack of coordination among public agencies & - - reliable data
- Lack of Legal Framework ; and Awareness and Participation by the Users

A brief account of the groundwater management problems - declining water levels, quality deterioration and pollution - along with some undue incentives is discussed below.

Depleting Groundwater Levels: Groundwater levels in many parts of the country have shown continuously declining trend in response to uncontrolled and extensive pumping. A number of studies have been carried out in the country to assess the groundwater management problems and their mitigation through joint program by public and private sector – without any significant achievement. Even systematic groundwater monitoring is not being done – except to some extent in the Punjab Province. Based on the data by Punjab Irrigation Department the groundwater level trends in some of the districts in southern Punjab – generally located in the tail reaches of the major canals is shown in Figure 3.4 given below:

Figure 3.4: Groundwater Level Trends in Multan Irrigation Zone (Punjab)

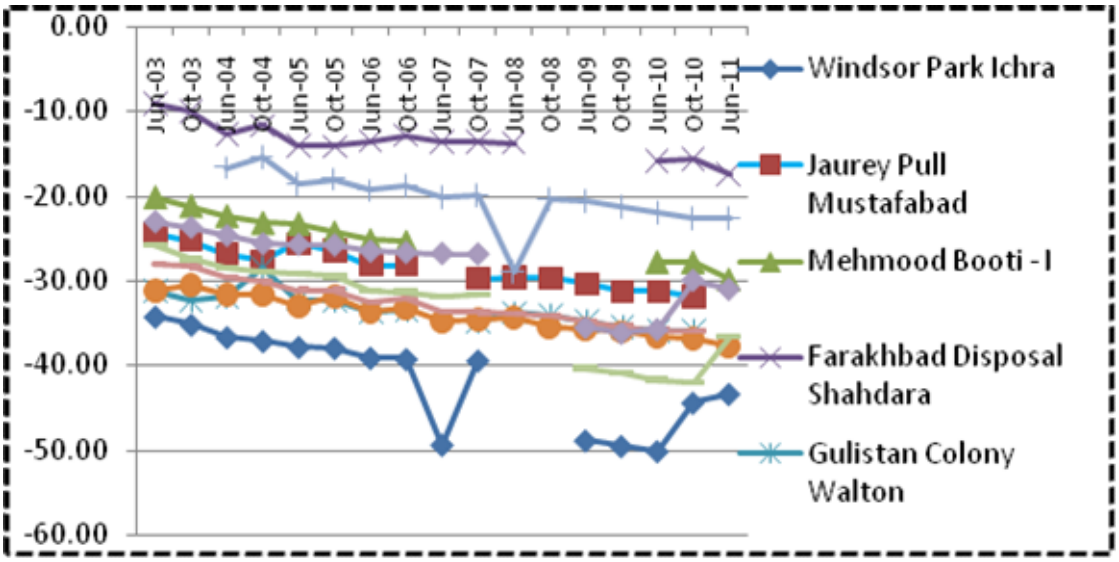


The above figure shows GW Level trends in Multan, Khanewal, Lodhran and Pakpattan - all showing a continuous decline due to uncontrolled pumping and the water table has gone even below 75 feet. Monitoring data shows that GWL is declining in almost all the tail areas.

Over Pumping in the Cities: Groundwater is used - generally - the main source of drinking water supply – all over the country. Examples from the two large cities of Pakistan viz. Lahore and Quetta – showing the increasing pressure on the aquifer - can show a clear picture of what may be happening to the other cities – like Faisalabad, Rawalpindi, Peshawar, Karachi, etc. Limited monitoring by the concerned agencies does indicate the aquifers under almost all the major cities are already under stress.

Lahore City: Almost 100 % of water supply for about 6 Million citizens. 4000-5000 industries and some agriculture around the city are based on groundwater. Response of groundwater levels at selected/representative tubewells in Lahore by WASA for the years 2003-11 is shown below in **Figure 3.5** (courtesy WASA Lahore & FODP):

Figure 3.5: GWR Trends in Lahore 2003 – 2011 (m)



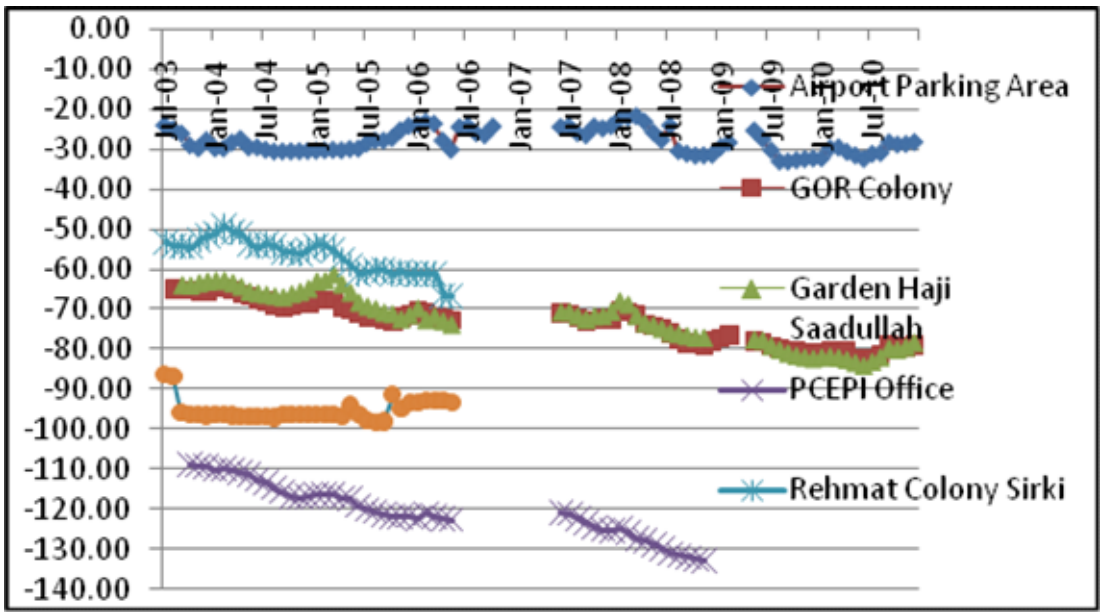
The above figure shows declining water table in all the parts of Lahore City. Presently, about 450 tubewells by WASA and around 4000 private tubewells are operating in Lahore.

Perusal of the above figure shows that all the tubewells have shown continuous decline of GWL. Review and analysis of GWL data indicates that during the last 8 -9 years:

- The decline of GWL has been from 4.61m (Gulistan Colony TW); to
- 10.85 m (Khizer Abad Mosque) depending upon the stress on the aquifer in the area and its characteristics.
- One thing – catching the eye is that already some tubewells are pumping groundwater from 50m depth to groundwater table.

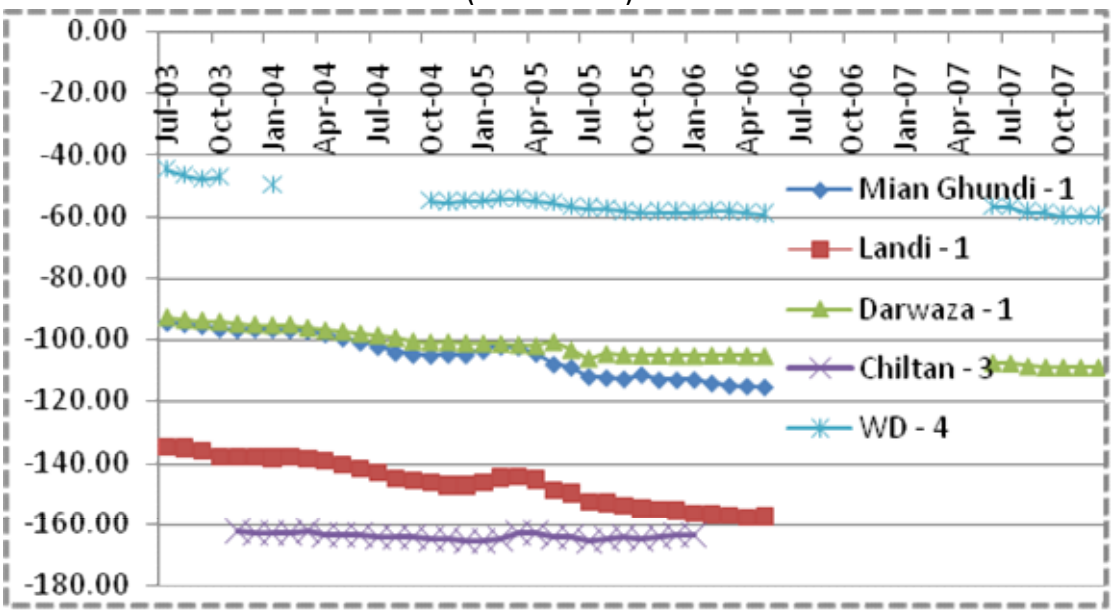
Quetta City: Aquifer under Quetta city has always been under stress due to excessive pumping. Lack of long-term vision and necessary precautions – the existing scenario is almost bleak. Monitoring by B- WASA Quetta and other agencies show the existing declines of groundwater levels as shown in **Figure 3.6** given below:

Figure 3.6: GWL Trend in Alluvial Aquifer Quetta Valley (m below GLS)



In Quetta valley – after exhausting the alluvial aquifers - deep tubewells have also been installed in the limestone aquifers – considering them some relief but these have also shown continuous declining trends - as all the tubewells are drawing water from the same bowl. Response of the wells constructed in the consolidated rocks is as Figure 3.7 given below:

Figure 3.7: Time Rate Changes in GWL in Limestone Aquifer Quetta Valley (M below GLS)



GW Management Problems in Pakistan: GW management problems can be attributed to physical, social, institutional and policy constrains – interacting & tied to each other. Major GW management problems in the country include the following aspects (box) are briefly discussed below:

Groundwater Management Problems

- Groundwater Depletion/Overdraft
- Saline Groundwater Intrusion
- Water Logging and Soil-Salinity
- Groundwater Pollution
- Non-Availability of Outfall for Drains
- Lack of Reliable Data
- Power for Private Tubewells
- Lack of Coordination among Public Agencies
- Legal Framework
- Lack of Awareness and Participation by the Users

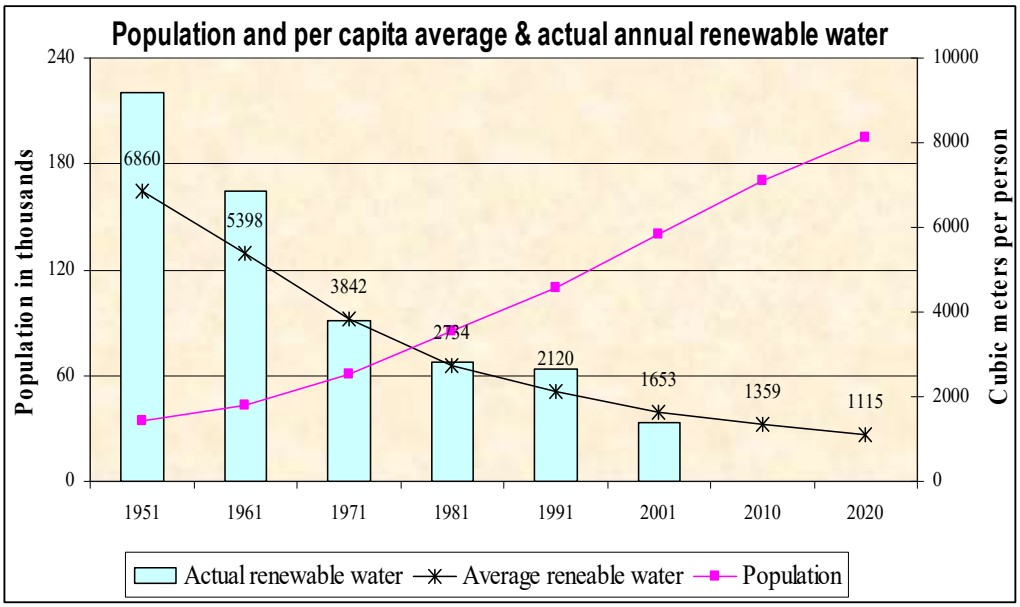
3.6 Climate Change Challenges of Pakistan

Many studies have tried to explain monsoon patterns in Asia. Studies show that Upper Indus Basin has permanent snow cover of 18000 square km by 5000 glaciers, stored volume of ice 1500 cubic kilometers and even larger permafrost areas (Kenneth Hewit). High altitude snow avalanche and GLOF based floods glacial outburst floods generated by surging tributary glaciers blocking main un-glaciated valleys; such an event has caused extreme floods in the past (Archer, 2002). Possible impacts on water resources of Pakistan are as below:

Climate Change & Pakistan Water Resources: Pakistan' primary sources of water are glaciers and snow melt from Hindu Kush-Himalayan and Karakoram ranges and rainfall brought by monsoon and westerly winds. The glacier melt contributes 50-80% of 170 billion cubic meters average inflows during six to eight months, i.e. freshwater systems are concentrated to summer and highly sensitive to climate forcing. The economy of Pakistan is highly water dependent with agriculture as the largest sector and user of water, receiving 85% of water, providing 40% employment and 24% of annual GDP. On the average about 75% of annual renewable water is diverted for uses. The current energy and economic crises make it essential to focus on hydropower (WB 2006, WAPDA 2008) as a cheap, renewable and cleaner source. The national development demands more water in all sectors. The needs of urban and industrial sectors will be exponentially increasing, requiring secure supplies over the year and water transfers across the sectors and regions.

Current knowledge and monitoring of climate changes in HKH region and Indus plains of Pakistan is limited, patterns of glacier melt and rainfall feeding Indus River system not well understood. To design and apply good mitigation and adaptation strategies, actions needs to be taken in many areas, including policies, institutional capacities and stakeholders' agreement on development options. Pakistan is increasingly facing multi-dimensional water stress with an added vulnerability caused by high annual variations. The river inflows vary from 110 MAF (2001) to 200 MAF (1993), while annual rainfall may vary from 30 MAF (2001) to 110 MAF (1993). Per capita freshwater availability based on average and actual renewable resources from 1947 to 2025 is shown in Figure 3.8. The actual availability substantially decreased between 1951 and 1981 because of Eastern Rivers. The decadal averages show a variability of 25% from wet to dry span (1991 versus 2001).

Figure 3.8: Population and per capita renewable water availability



Possible Impacts of Climate Change on Water Resources of Pakistan

- Higher runoff during glacier melting phase increasing lake formation and lake-outburst floods in surrounding areas - eventually increased river flows and floods in plains. The topographic instability can increase extreme events like glacier and land sliding, sediment flows, etc.
- Intensive but erratic monsoons and winter rainfall. Higher temperature differences between land and sea causing rains and cyclones in coastal areas.
- Higher evapo-transpiration affecting different components of water cycle; decreased soil moisture, higher water demands, new demand peaks
- Unexpected droughts
- Local floods and new waterlogged zones
- Changes in aquifer recharge patterns causing new waterlogged areas, and
- Quality deterioration of water stored in surface bodies and groundwater
- Elimination threats to freshwater eco-systems
- Fogs (toxic) close to urban areas, water bodies and high water use systems
- Formation of new climatic-ecological-agro zones

We as a nation have to be prepared to assess any hazardous impacts on groundwater regimes and implement necessary measures to attain the sustainability of the groundwater resources.

3.7 Way to Optimal but Judicious Groundwater Use

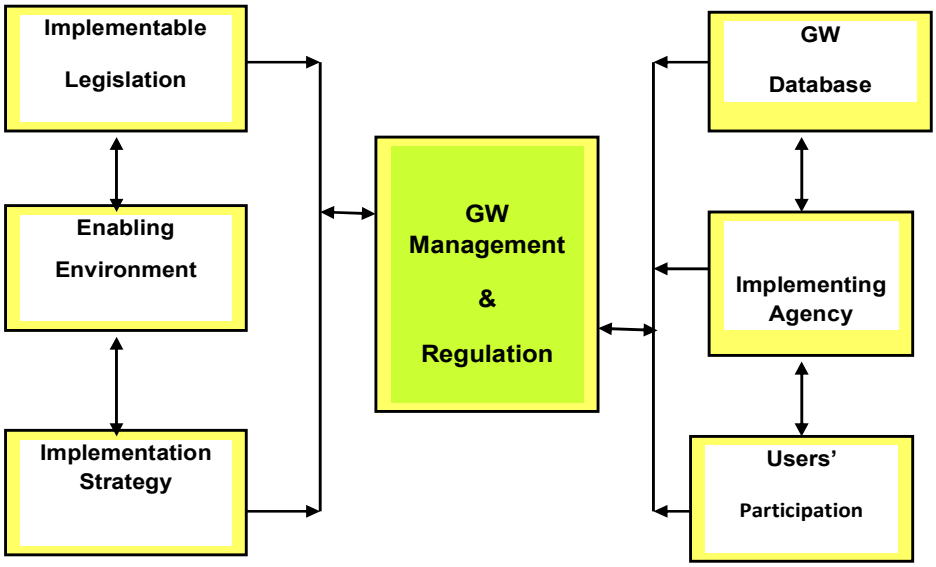
Following factors need to given due consideration for optimal but judicious use of groundwater:

- Address groundwater quality deterioration;

- Protect groundwater from pollution;
- Reverse the continuous lowering of groundwater tables, especially in the Barani areas and the canal commands in Punjab;
- Set the finances and institutions right;
- Withdrawal of un-necessary incentives on electricity for agricultural tubewells; and
- Address remaining water logging, particularly in Sindh – by promoting skimming wells and reducing canal water in some areas.

Building Stones for Groundwater Management: Building stones for groundwater management are a sound database, an institution with responsibilities for monitoring and management in collaboration with the groundwater users and enabling environment for achieving desired targets – as shown in the Figure 3.9 – given below:

Figure 3.9: Building Stones for Groundwater Management



Point Needing Attention

Limited Fresh Groundwater on Earth:

Fresh water is already limited in nature viz. a viz.:

- Out of the 1400 Km^3 of water on earth - around 97 % is saline and in the oceans; whereas;
- Fresh water on earth is only about 3% and out of this 75 % water is in the form of glaciers. Of remaining fresh water the groundwater is the major source - as 24% (of Fresh water) and surface water (rivers, streams, lakes) only as 1%.

3.8 Key Areas of Concern and Existing Gaps

Policies of water and water use sectors: There is need bringing uniformity in water policies and water use sectors, viz. (Planning & Development Division paper):

- Accounting & Service: demand estimates, gaps, priorities, aggregate data, actual uses in different sectors
- Coherence of policies
- Strategic challenges: emerging trans-boundary issues (including Kabul), strengthening Indus commission to protect IWT- protecting national rights, interpretation and internal understanding of the gaps (esp. measures to protect western river flows) & new areas like environmental flow, groundwater.
- Sector management: downscale & revisit sectoral needs and existing uses as well as upscale for long term comprehensive planning
- Draft water policy needs to be improved and approved
- Provincial agreement on development approach
- Institutional responsibilities: especially provinces should set clear rules and accounting procedures

3.8.1 Water Strategies:

General issues: long term planning (no basin level study after 1990), agreed alternatives and implementation; and

Specific Issues: Water accounts, data, unaccounted uses, water stress, large and small storages and realistic water conservation potential, wastewater reuse viz. a. viz.:

I. Approach to approve National Water Policy, Water Councils and Enhanced Provincial Ownership

II. Development of New Water Resources

III. Account, Protect and Optimize Existing Water Resources

IV Groundwater Protection Plan

V) Actions to Protect Local Water Access

IV. Water Supply Commitments

V. Water for Food Security

VI. Knowledge Base Tools - - -AND

VII Awareness & Active Involvement of Users – Farmers use 90 % of Groundwater.

3.9 Lesson from Neighboring Country

Neighboring country is already enjoying the fruits of continuous development of their land and water resources and is already much ahead of us in production of food per unit volume of irrigation water. Some of the recent studies and in the process of implementation are as below:

3.9.1 Concern for Quantitative Management and Groundwater Recharge

Study on Intensive Groundwater Exploitation in the Punjab – an Evaluation of Resource and Quality Trends (Groundwater Science Programme Open Report R/14/068): Neighboring country India has carried out tremendous groundwater development and turned Eastern Punjab into Food Grain Basket for whole of India. Recently a comprehensive study has been carried out by IGWB in collaboration with British Geological Survey titled as, "Groundwater resilience to climate change and abstraction in the Indo-Gangetic basin". The project (in Bist Doab) has two main aims:

- To develop a strategic overview assessment of the occurrence and status of groundwater resources in the Indo-Gangetic basin and develop a map of groundwater typologies spanning the groundwater system; and
- To strengthen the evidence-base linking groundwater resources, climate and abstraction through a series of four targeted case studies in the basin.

The intensive farming carried out in this region largely relies on pumping from the shallow aquifer (0-50 m) and uses large quantities of fertilizers and chemicals to control pests and sustain yields (Chaudhary et al., 2000; Kuldip-singh et al., 2013). In responds to the groundwater security issues in Punjab a number of initiatives are being implemented by the state government for improving water use efficiency, these include:

- Propagation of irrigation water saving techniques, for example laser grading of fields, zero tillage and directly seeded rice;
- Rainwater harvesting and recharge structures are being constructed in the sub-mountainous region
- A subsidy of up to 85% on micro-irrigation, a 50% subsidy on underground pipeline systems to individual farmers, 90% subsidy for the community underground pipeline projects
- Watershed management projects are being implemented in 26 locations.

3.9.2 Concern for Groundwater Quality

Water Quality Concern: A recent study by Greenpeace India Society (Nemani Chandrasekhar, October, 2011) is an initial investigation into the effects of synthetic nitrogen fertilizer on groundwater pollution in intensive agriculture areas in Punjab. The level of nitrate in drinking water was tested from groundwater artesian wells located within farms and surrounded by crops (mostly rice and wheat rotations).

Testing of Nitrate Pollution

- Nitrate pollution in drinking water can have serious health impact on humans, especially for babies and children. The most significant potential health effects of drinking water contaminated with nitrate are the blue-baby syndrome (methemoglobinemia) and cancer;
- As a part of the study, groundwater was tested from artesian wells located in farms away from other potential sources of nitrate contamination (animals, human sewage), in order to focus on the impact of fertilizer application. Farms located in three districts (Bhatinda, Ludhiana, Mukhtsar) in Punjab where fertilizer consumption is highest were sampled;
- The investigation in three districts of Punjab shows that 20 percent of all sampled wells have nitrate levels above the safety limit of 50 mg of - nitrate per liter established by the World Health Organization (WHO). Also, this nitrate pollution is clearly linked with the usage of synthetic nitrogen fertilizers as higher the application of nitrogen (urea) in the adjoining field, the higher the nitrate pollution found in the drinking water from the same farm.

Synopsis: Capturing the river flows and intensive groundwater abstraction by the neighboring country - by providing incentives to the farmers for growing more food – is definitely placing pressure on the groundwater regime – which one day will affect the groundwater flow system in the downstream areas of the Pakistan Punjab. We have to keep a watch on the ground conditions for the sustainability of our groundwater – which is directly related to surface water - major source of groundwater recharge is the seepage from irrigation system – *"less surface water flows and less groundwater recharge".*

4. TRUTH ABOUT WASTE-WATER: AN ECOLOGICAL NIGHTMARE

Muhammad Shamshad Gohar, Suleman Najib Khan

4.1 Water is life and a Special Gift of God

4.1.1 Background & Existing Scenario

Pakistan is, mainly, an agricultural country and its' economy – particularly in the rural areas – greatly depends on agriculture oriented activities. Agriculture involves 47 % of the workforce and contributes 25 % of GDP and 60 % of the export. As the country lies mostly in semi arid region - dependable irrigation for production of food and fiber for around 180 Million people is but a sine qua non. Developed surface water resources – existing canal supplies on an average are around 105 MAF - and hence, groundwater has played the critical role for meeting the crop water requirements and provision of drinking both to urban and rural populations.

There has been a tremendous groundwater development in the last 3-4 decades, due to dedication by the farmers, who presently operate around one million private tubewells (PTWs) in the country, mainly, for agriculture and drinking water requirements. Nearly 90 percent of the total groundwater abstraction - estimated around 50 – 60 BCM - is being used for agriculture.

Population growth and increasing demand of water for irrigation, water supply, industry and environmental needs would further boost its importance in the years to come. Drought conditions during 1998-2003 led to acute water shortages and illustrated just how close water use is to the limit of the resource. The importance of groundwater for our food and fiber is increasing as we have to ensure the sustainability of this invaluable resource which is under great threat due to:

- Uncontrolled development of groundwater; and
- Unchecked discharge of agricultural, industrial and sewerage effluents into surface and groundwater regimes

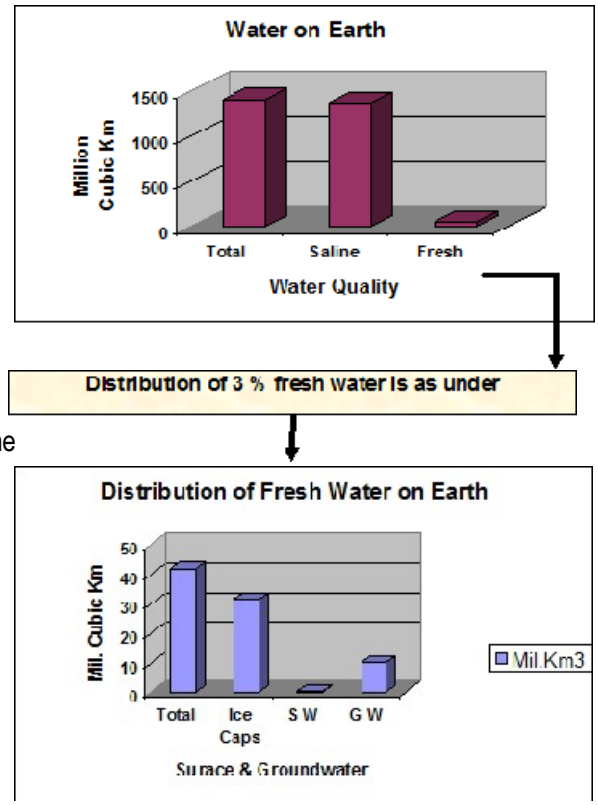
The aquifer has already started showing adverse side effects of:

- Groundwater mining; and
- Quality deterioration and ultimately to hamper the agricultural growth and threat to the availability of "safe drinking water".

Accordingly, there is a need for systematic management and regulation of the resource for its optimal but sustainable utilization. However, the existing situation in larger parts of the country is far away from moving towards improvement due to our lack of interest.

4.1.2 Importance of Safe Drinking Water

Water is Life – but Safe Drinking Water: Water is a blessing from Allah and the most important element for the survival of the living beings. However, we the human beings need "safe drinking water" as we do not have the necessary resistance like animal kingdom or the herbs to absorb "contaminants" such as bacteria, excessive salt contents, heavy metals beyond traces, coli forms, dirt particles etc. More than 70 % of the diseases in the developing countries are due to the "unsafe drinking water" and the cause of more than three (3) million people's death every year. It is estimated that one third population of Asia lacks the basic facilities of safe drinking water and sanitation services.



Global Distribution of Water – Limitation of Fresh Water: Total water on earth is of the order of 1400 million cubic kilometers. Ironically more than 70 % of the earths' surface is covered with water in the form of seas and oceans - this water comprises 97 % of the total water on earth but it is saline and unfit for human use. Of the remaining 3% remaining water 75 % (or 2.5% of the overall total) is in the form of glaciers and only 25% (or 0.25% of the overall total water on earth) is in the form of surface and groundwater.

Major Challenges: This 0.25% of global water is the "water" that we human beings are struggling to develop, conserve, use and/or waste and contaminate through our negligence and lack of due consideration. So under the present circumstances the major challenges warranting immediate attention include:

- Guaranteed availability of safe drinking water in adequate quantity to all people regardless of income or social status;
- Combating the "dragon of pollution" as every year, some 3.4 million people, mostly children, die from diseases associated with inadequate water supply, sanitation and hygiene.

A brief account of the existing situation – related to water availability and pot ability - water safe for drinking and even irrigation, industry and some for protection of ecosystem is discussed below.

4.2 General Distribution of Groundwater Quality

Groundwater quality is influenced by the structural, depositional as well as physiographic features and the recharge potential through rainfall. The parent rocks in the mountain ranges are predominantly calcareous – thus the groundwater, in the northern parts and the recharge zones, is characterized by a gradation starting from calcium-magnesium bicarbonate type in the fresh waters to a dominant proportion of sodium in the most saline waters. In terms of suitability for irrigation, usable water of about 500 to 1,000 PPM dissolved solids is commonly of the sodium bicarbonate type; with marginal water

there is increasing mineralization from about 1,000 to 2,000 PPM, the relative proportion of chloride and sulfate increases. The unusable highly mineralized groundwater (4,000 to 20,000 PPM) is generally of the sodium chloride type (in the central parts of the Doabs) but in areas west of the Indus Plains, sodium sulfate water pre-dominates. Groundwater quality in the inter-mountain valleys of Balochistan and NWFP are generally good. In spite of the large variations the general aerial and vertical distribution of groundwater quality in the above-mentioned hydrologic zones area as below:

In the Indus Plain, the quality of groundwater is generally fresh along the rivers and brackish in the central parts of the Doabs. The sediments underlying the Indus Plain were deposited in the receding sea - originally were highly saline - and the rivers have flushed these sediments along their channels. Due to the continuous seepage from the irrigation system during the last century a thin layer of fresh groundwater has been formed, which is being tapped by the farmers through shallow skimming wells.

In the Inter-mountain valleys and basins, the chemical quality of groundwater is generally fresh in the areas covered by the alluvial fans and the piedmont deposits and deteriorates towards the central parts. However, the groundwater quality also depends upon the types of the rocks comprising the recharge areas for example the areas with sand stones, lime stones have relatively fresh groundwater as compared to the areas underlain by clays and shale.

In Cholistan and Thar Parker, the groundwater quality is generally poor except small pockets underlain by the channel remnants. Photograph on the right shows women pumping drinking water from a hand pump installed along a distributary for skimming FGW.

In the Makran coastal belt, FGW is only available at shallow depths as the sediments underlying the belt are generally of marine deposition.

General picture of the aerial and vertical distribution of groundwater quality in all the four provinces is briefly described as below:

4.2.1 04-21 Groundwater Quality in Punjab

Sediments underlying the Punjab Plain were deposited in a continuously receding basin (The Teythis). During the geologic past in Eocene Period (around 6 million years ago) - simultaneous rising of the Himalayas, subsidence of the basin, and regression of the sea resulted in the deposition of a huge alluvial complex. The sediments deposited during the process retained the brackish/saline water trapped in them. The rivers kept on adjusting their profiles of equilibrium to maintain their flow regime. During the Quaternary Era the meandering rivers flushed these sediments in their flood plains and hence, the chemical quality of groundwater is generally:

- Fresh in the areas along the rivers;
- Brackish/saline in the central parts of the Doabs;
- Fresh in the Pothwar Plateau;
- At the foot of Suleiman Range (DG Khan and Rajanpur districts), it is fresh along the Indus and brackish on the piedmont slopes; and
- Predominantly brackish-saline in the Cholistan Desert.

4.2.2 Groundwater Quality in Sindh

Groundwater quality in Sindh is generally fresh and useable (within 1500 PPM) along the Indus and in the irrigated area and deteriorates away from the river. The native groundwater of the Lower Indus Plain is highly saline being of marine origin. Photograph on the right shows shortage of drinking water in Thar.

In the piedmont belt along the slopes of the mountain ranges the groundwater quality is generally poor with pockets of useable water. The deltaic area south of Hyderabad is saline water area, except in some shallow pockets in the abandoned riverbeds of Gaja area.

4.2.3 Groundwater Quality in Khyber PakhtoonKhwah (KP)

The quality of shallow groundwater in the valleys, which is largely derived from infiltration of rainfall and seepage from canals and fields, is generally good (less than 1500 PPM of dissolved salts). However, in Bannu Basin, the chemical content of the upper horizon ranges from 350 to 3000 PPM. Modern developments in agriculture and industry and changing lifestyles and consumption patterns of the population carry the risk of widespread groundwater contamination. Notable pollutants are fertilizer, nitrate and non-bio-degradable pesticides and herbicides from agricultural activities; industrial wastes and the wastes from mining operations; and organic wastes and bacteriological contaminants from domestic activities.

4.2.4 Groundwater Quality in Balochistan

In piedmont plains and the valley floors of northern region of Balochistan, comprising Zhob and Pushing Lora, the quality of groundwater is generally fresh. In the western and south western parts quality of groundwater is saline to highly saline at depths – being connate water in the basins like Hamune-e-Mashkel. In coastal area of Balochistan, quality of groundwater is particularly poor due to seawater intrusion. Igneous and crystalline rocks generally yield groundwater of excellent quality with salt concentration commonly below 100 mg/l and seldom over 500 mg/l.

4.3 Deterioration of Groundwater Quality and Pollution

In Pakistan - groundwater provides about 90 % of the water for drinking and domestic requirements. However, groundwater resource – in larger part of the country - is under a greater threat due to over/haphazard and uncontrolled pumping and increasing pressures from the pollution dragon – as indicated in the box given below:

- Abnormal lowering of water table – particularly in the tail reaches - making the pumping more expensive, depriving farmers from using groundwater; which is resulting in
- Saline groundwater intrusion in the areas adjacent to the SGW zones due to excessive pumping in fresh groundwater areas due to lateral or vertical intrusion of SGW;
- Pollution of surface and groundwater due to unchecked discharge of industrial and sewerage effluents.

Due to the unchecked discharge of industrial, sewerage and agricultural wastes into the surrounding water bodies there is increasing threat from the **Pollution Dragon**. Both the surface water and groundwater sources are beyond safe use - as discussed below.

4.3.1 Water Quality of Natural Streams

Water quality of rivers, lakes and canals is degradation (Environmental Concerns Study II &III, PCRWR, Drinking-water schemes reports). The causes include direct discharge of city and industrial effluent, failure of surface drainage and trans-boundary pollutions. However, quality deterioration of freshwater bodies is directly linked with flushing potential of the system and balanced groundwater recharge. Few examples of reported pollution and its causes:

- Ravi pollution: toxic industrial and domestic effluent from India & Pakistan.
- Kabul river pollution - urban and domestic effluent -
- Chenab River reaches - urban effluent
- Lower Indus lakes – urban and irrigation drainage
- Natural Ecosystems have decreasing freshwater supplies and resilience

4.3.2 Groundwater Pollution

Apart from the constraints on the total availability of surface and groundwater in the country – the existing water sources are being rendered un-usable due to pollution of surface and groundwater bodies — the water contaminants even percolate into the groundwater regime and make groundwater unsuitable for drinking purposes – the top priority in any civilized society.

Arsenic Contamination in Drinking Water:The greatest challenge of the day is the increasing danger of groundwater pollution due to the industrial, sewage and agricultural effluents finding their way to the groundwater regime. Groundwater quality study carried out by UNICEFF and Pakistan Council for Water Resources Research (PCRWR) in 17 districts of Punjab and Sindh in 2003 found alarming results - especially the Arsenic contamination in groundwater had been found in 4-5% sampling sites beyond the permissible limits of the WHO. Whereas around 20 % of the sampling sites indicated Arsenic above the safe limits of 10 PPB – as per WHO guidelines.

Bacterial Contamination - Pollution of Groundwater Aquifer: Continuous discharge of industrial, sewage and agricultural effluents are posing another threat to the availability of potable water to - both the urban and rural communities. In spite of efforts by the federal and provincial EPDs and other public and private agencies necessary awareness of the stake holders and the discharge of industrial, agricultural and sewage water has not been controlled by the concerned authorities. This has resulted in the contamination of the surface and groundwater – particularly from drinking point of view. Some of the recent studies conducted by PCRWR to assess the suitability of water for drinking include as shown in Table 4.1:

Table 4.1: Studies Conducted for Water Quality

Survey	Results
Water quality survey under Multiple Index Cluster Survey (MICS) of about 91,280 drinking water sources in Punjab, 2005-06	51 % of samples (44, 844) were found unfit due to bacterial contamination, Arsenic or Fluoride
Water quality survey under Punjab Education Sector Reform Program: Collection of 44,717 drinking water sources from schools in, 2007-08	6 % were found unfit from bacterial contamination and 17 % from Arsenic contamination
Water quality monitoring survey in Pakistan – at Union Council level in all the four provinces, 2008-09.	Results indicated that 64 % to even 92 % samples were found unfit for drinking water.

Excessive / Untimely Use of Fertilizers & Pesticides: Use of Nitrate Fertilizers, Pesticides and Fungicides is also threatening - through continuous use, in some areas overuse and untimely use for boosting agricultural production and then unchecked discharge into surface water bodies and open lands is creating threat to life as these chemicals find their way back to the kitchens through vegetables grown particularly around the human settlements. Studies conducted under Punjab Private Sector Groundwater Development Project (PPSGDP) by IPD Punjab and WB in 1997-2001 for "Environmental Assessment and Water Quality Monitoring Program in the areas near industrial clusters (Technical Report-54) highlighted the following life threatening concerns:

- 90 % of the groundwater samples were contaminated with arsenic (As) and exceeded the WHO maximum recommended value for drinking;
- 70 % of groundwater samples exceeded the WHO maximum limit for Selenium (Se); and
- 40 % of samples show higher concentration of Lead (Pb) than WHO permissible limits;

This problem might have even increased under the existing conditions. Possible sources on contamination and their ill effects are shown in Table 4.2.

Table 4.2: Potential Health Hazards of Geological and Organic Contaminants

Contaminants	Potential Health Hazard from Ingestion of water	Sources of Contamination in drinking water
	Inorganic Chemicals	
Arsenic	Skin damage; Circulatory system problems; Increased risk of cancer	Erosion of natural deposits; Run off from glass and electronics production wastes
Fluoride	Bone disease (pain and tenderness of the bones); Children get mottled teeth	Water additive which promotes strong teeth; erosion of natural deposits; discharge from fertilizer factories
Lead	Delays in physical and mental development among infants & children; Kidney problems and high blood pressure for adults	Corrosion of household plumbing systems; Erosion of natural deposits
Cyanide	Nerve damage and thyroid problems	Discharge from fertilizer factories
Chromium	Allergic dermatitis	Discharge from steel and pulp mills; erosion of natural deposits
Mercury	Kidney damage	Erosion of natural deposits; Run off from landfills and crop lands
Cadmium	Kidney damage	Corrosion of galvanized pipes; Erosion of natural deposits
Nitrite (measured as Nitrogen)	Blue baby syndrome in infants	Erosion of natural deposits; Leaching from septic tanks
Nitrate (measured as Nitrogen)	Blue baby syndrome in infants	Erosion of natural deposits; Leaching from septic tanks
	Micro-organisms	
Total Coli forms	Used as indicator that other potentially harmful bacteria may be present	Present naturally in the environment. Comes from human and animal fecal waste

4.4 Challenges & Key Points Needing Attention

Kill Pollution - Save Life of People: Top priority for any civilized society has to be the provision of safe drinking water to all the people - and even the animals surrounding us. All efforts should be focused on the mitigation and eradication of the pollution dragon. Under the present conditions sewerage water, industrial and agricultural effluents are discharging into our surface water bodies (drains, rivers, lakes, etc) and groundwater regime. This has resulted in surface and groundwater - even in our ideal fresh groundwater areas like Gujranwala and Sialkot – questionable for drinking – mainly due to the

uncontrolled discharge industrial effluents. Due to the race for pumping more and more and leaving the sewerage, industrial and agricultural effluents to find their way to any surface water body or groundwater regime - our groundwater reservoir is facing these problems:

- Increase in salinity of groundwater;
- Health hazards due to the groundwater pollution; and
- Continuous lowering of water levels

Pollution Dragon still haunting us:A number of studies carried out by various agencies (including PCRWR) on:

- Water quality drinking water sources indicate; that
- The Pollution Dragon is still haunting us.

As s sample - to indicate the water quality problems based on PCRWR, "Survey of Water Quality in Schools of Punjab, 2008-09" (as a part of survey water quality checks were conducted at 46,717 schools) is being reproduced(Table 3.23). This table can provide some good picture of the water quality situation in other parts of the country.

PCRWR Table 3.23: Summary of Water Quality Monitoring in Rural Areas of Punjab (PCRWR Study)

Sr. No	District	No. of Villages Monitored	No. of Samples Collected	Status	
				Safe (%)	Unsafe (%)
1	Gujarat	223	1117	16	84
2	Sargodha	166	830	37	63
3	Rawalpindi	225	1125	30	70
4	Attock	87	435	15	85
5	Gujranwala	160	805	33	67
6	Sialkot	308	1543	55	45
7	Lahore	52	261	88	12
8	Kasur	127	637	45	55
9	Bahawalpur	243	1220	51	49
	Total	**1,591**	**7,973**		

Positive Action – but……

"Provision of Safe Drinking Water for All" about 6,570 water treatment plants will be installed in the country. Under this program one water filtration plant will be installed in each union council. In Punjab province about 3,534 filtration plants will be installed. The PCRWR has collected and analyzed 7068 water quality samples from 3534 locations where the filtration plants will be installed.

NB: *Work has been initiated & let us hope that it is completed. However, this is like distributing Nivquene tablets rather than killing the mosquitoes. Why not kill Pollution by checking discharge of contaminated effluents.*

We as a nation have to join hands – both public and private sector to save water through appropriate management and judicious use. So far, our national attitude has been relaxed and considering groundwater as free and unlimited – as shown in the box below:

Ensuring Provision of Safe Drinking Water: Pakistan is also one of the "water scarce" countries. In spite of the fact that our annual availability of water is estimated around 400 billion m^3 (total rainfall and the surface water inflows), the availability of safe drinking water for 150 million people is becoming more and more difficult due to the increasing pressures on the water resources for agricultural, industrial and drinking needs and particularly the increasing pollution of both surface and groundwater resources due to the increasing disposal of untreated waste from agricultural, industrial and sewerage wastes.

Recent studies by PCRWR and UNICEFF and shown that another dragon id threatening the availability of safe drinking water due to the existence of "Arsenic" at shallow depths. The areas located in the near vicinity of industrial zones and/or in the down gradient areas have already started showing contamination of groundwater especially at shallow depth. A large number of cities and towns from Islamabad to Karachi are under distress due to industrial and sewerage pollution.

The situation in the rural areas can be assessed where people are stressed to drink water from the locally developed / unprotected water points. Picture of the right shows people carrying drinking water for sale in Kasur district of the Punjab – and situation in other provinces can be well imagined.

Keeping in view the health and safety of people – our top priority should be provision of safe drinking water. There have been some efforts in the past on this aspect – but we have to ensure water and sanitation - all over the country.

The Way Out

- It is high time that - we all Pakistanis – join hands in saving life and bread for current population and leave a good scenario the future generations;
- A large number of studies have been carried out in the past - and also in collaboration with the international agencies; but
- We (as a nation) have not shown a serious concern towards the deteriorating situation in the management of our water resources... **it is time to get up and get together; and**
- Ensure the provision of "safe drinking water" to all the communities - particularly in the rural areas.

4.5 Waste Water – National Dilemma

4.5.1 The health, pollution and sanitation issues:

First requirement of civilization is clean water and effective sanitation. The belief that running water is clean even if it is sewage or industrial effluents is very dangerous & idiotic. A UNICEF report states:
…… that worldwide; safe drinking water and sanitation are basic to human survival, dignity and productivity. Lack of these fundamentals is one of the main underlying causes of malnutrition disease and death in children. Over 1 Bn people including millions of children lack access to safe drinking water. More than 2 Bn people lack access to sanitation. Pakistan is amongst the worst in Asia. Hepatitis is rampant. TB is re-emerging.unquote.

Pollution is the other menace also resulting from automobile and unchecked exhaust. Particulate Matter (PM) should not be more than 70 micro grams/cum. PM is a complex mixture of extremely small particles and liquid droplets. It could include nitrates and sulphates, organic chemicals metals and soil /dust particles. Also acceptable NOx standard is 40 but in city centers including Lahore it is around 100. NOx is the generic term for a group of highly reactive gases all of which contain nitrogen and particulates. It is primarily a result of fuel being burnt at high temperatures. High arsenic content in ground water is very harmful and caused by unchecked aquifer mining. We must understand that PM, NOx and Arsenic are responsible for severe health problems and countless mortalities.In Pakistan's +50,000 villages and +1000 towns / major cities we find that pools of stagnant and dirty water create millions of colonies for mosquitoes (and flies). Union councils, town committees and municipalities have stopped trying to eliminate this menace. Again Indians and Chinese are doing better at fighting malaria because in the villages all three nations lack drainage infrastructure. In India they may not be able to prevent the malaria parasite but Indians and Chinese are developing health centers to destroy it within 24 hours of infection to avoid complications. The Chinese whose generally cool weather is helpful use new malaria parasite killers such as Atamisanan plant.

Prenatal care and gynae centers in villages and rural areas are non-existent. The mountainous regions of Northern Pakistan are also suffering from all the above shortcomings as the rural areas of the plains. Where there is no piped water the water-borne ailments such as diarrhoea are rampant killers. In the Northern area the poor quality piped water has shown that without evaluating& controlling the source a piped water scheme may not be installed haphazardly.

The challenge for Pakistan is to secure both its urban &rural water supplies. New technologies & knowledge base is required. The treatment of wastewater also for reuse & recycling is now unavoidable. This is as important as higher efficiency ways of using water in irrigation, in rural & urban areas and for the environment. New supplies will have to be added through recycling technologies and better use of groundwater. Ground based radar and satellite based remote sensing technologies can provide valuable help to measure rainfall & improve forecasting skills. One day flow measurement via satellite could alsobe routine. IWT1960 is sacrosanct but be aware of Helsinki Rules 1966 as the UN's recognition of Ecology in both SW& GW domains.

5. KARACHI AND LOWER SINDH: WATER SUSTAINABILITY IN URBAN AREAS

Dr. Bashir A. Chandio, Dr. Syed Imran (KU), Mustafa Zuberi

5.1 Lower Sindh

Water is the lifeline for development of Pakistan. It is the main endowment with the nation. Agriculture is its main consumer, and energy sector is its oblige.

Rivers	Average Annual Flow Between 1922 and 1961 (MAF)	Average Annual Flow Between 1985 and 1995 (MAF)	Average Annual Flow between 2001 and 2002 (MAF)
Indus	93	67	48
Jhelum	23	27	12
Chenab	26	28	12
Kabul	26	23	19
Total	**168**	**145**	**91**

The most pervasive issue of economics related to water quality is the cost of water. The use of subsidies though has brought many benefits but has also brought problems. The difficulties in water system pricing for different group of users should candidly be addressed. The politics of elected representatives in the wake of dictatorial interferences make decision making more complicated. The environmental and social impacts both positive and negative can be exacerbated or ameliorated by the institutional settings (Irrigation Induced Water Quality Problems (National Academy Press, Washington DC 1989). As traditional water resources of Pakistan are mostly developed, country has to look into new venues like saline water use, desalination of sea water, and recirculation of municipal effluents.

Sindh is a lower riparian of Indus Basin in the same manner as Pakistan is lower riparian to India. Besides, it is a drainage valley for Pakistan where Left Bank Outfall Drains (LBOD) and Right Bank Outfall drains (RBOD) discharge their effluents. It is suffering from highest salinity problems. Its ground water is mostly non-useable though is seeking balance between saline groundwater inflows, River Indus surface flows beyond Kotri, and upward encroachment of brackish water. A simple Ghyben Herzberg equation suggests that one foot height of brackish water requires forty feet of fresh water to maintain equilibrium.

Whereas industrial wastes could be made useable only after heavy treatments, agricultural return flows are considered as useable wastes. Nonetheless, in near future, industrial and municipal partners would be demanding for their share at the price unaffordable to agriculturists.

1) Increase productivity of land and water by:

   a. Mitigating salinity water table control in the soils;

   b. Sluicing of silt from reservoirs and canal network downstream river;

   c. Land drainage through better development and management skills;

d. Better pricing of crop yields through scientific marketing ;

e. Providing subsidies on farm inputs and/or reducing Government taxes.

2) Building replacement or carry-over reservoirs for augmentation of existing irrigation system;

3) Constructing new hydel projects on replacement dams, and other feasible sites in Northern areas;

4) Encouraging river bank storage as trade-off to reservoirs and inducing riverine forestry;

5) Rehabilitating biodiversity in the flood zones and estuaries.

5.2 Karachi

5.2.1 Water Issues in 2015

Clean and adequate amount of water is essential to the survival of the human race during everyday life. However, this scenario is not true in many parts of the world including Pakistan, and more specifically for Karachi, the largest metropolitan city in the country. Karachi, being one of the fastest growing cities of the world, having an estimated population of more than 20 million spread over an area of 2787 km^2, currently facing the issue of water supply and water quality as one of the city's biggest problems.

Karachi gets water from two major sources; one is the Kinjhar Lake (Kalri) fed by Indus River that is 100 mile away from the city, and the other is Hub Dam, which is 60 km in the northwest. Hub dam supply quota is 100 Million Gallon per Day (MGD) water supply to the southern part of city. However, it provides only 25 MGD to city these days, due to lesser rainfall during the last two years in the catchment areas of the Dam and it is anticipated that water supply from this source will not be available before the next monsoon season. Karachi also has quota of 1200 cusec water from River Indus; however, the original design capacity of the source stood at 650 MGD which is approximately 60% of the demand. Out of 650 MGD of water, 33 MGD are diverted to Pakistan Steel Mills and Port Qasim for industrial use. Remaining 200 MGD are supplied to the northern and eastern parts of the city, 180 MGD to Gulshan-e-Iqbal and its adjoining areas, 140 MGD reach the COD Filtration Plant near Civic Centre and the remaining 30 MGD to Karsaz. Six bulk consumers, including the Defence Housing Authority (DHA) and industrial areas alone get more than 20 percent of this water supply, which is 125 MGD. The development of Bahria Town, Karachi would be another addition to the list of bulk consumers, since there is no other source of water for this housing scheme. A large number of people in the city live in slums or homes without built-in piping to provide running water. This leads to issues of lack of supply, unmonitored water use, improper wastewater disposal & pollution. This is only the second half of the equation. How are the water treatment plants and infrastructure set up before water quantity reaches the people?

The sole manager of Karachi's water system is Karachi Water & Sewerage Board (KW&SB). Water is collected and treated by the conventional water treatment plants, and distributed by a system that is at least 65 years old with some new distribution facilities in the city. The outdated system with some superseded knowledge of how to properly operate and maintain it causes the issue of revenue loss. In addition, for domestic purposes, there is no water metering system in the city, rather billing is on the basis of plot size of the consumer's house.

It is important to focus on the unstable urban supply of water for Karachi, due to old water infrastructure and lack of adequate construction. Due to its age, it is crippled with pollutants and bacterial infestations. The estimated current population of Karachi is 20 million with an expected increase up to 32.5 million for 2025. Therefore, water demand and shortage are sure to surge in future. In many areas of Karachi,

especially suburb/underprivileged areas, water shortages are currently the norm. The underprivileged population suffer the greatest because they do not have the financial and infrastructure support to obtain water. The water that is currently supplied to Karachi is distributed unequally due to political pressure and mismanagement of administration. The article highlights the problems and possible solutions to the current distribution system, and how they are expected to intensify in the future and to propose new infrastructure or policies that can be implemented to address these problems.

A discussion about the origins of illegal hydrants in Karachi is believed to be as far back as 1995. All this started during late 1990s because of drought situation in Karachi and to the northwestern watersheds. There was not much water available due to less than average annual rainfall. The situation of water became dire and there was a chance of disturbance across the city. Therefore, rationing of water started with the help of Pakistan Rangers, originally deployed in Karachi to control law and order. In the beginning this water was free, and distributed in the areas where water supply was scarce through KW&SB system. Through the years and persistence shortage of water, the distribution of water got difficult, and water became the precious commodity for Karachites. Therefore, it became money-making industry by creating tanker mafia which has been patronized by various public, political, and private individuals.

Since Karachi is again in middle of drought conditions for the last three years, the already scarce groundwater, which is big help to Karachites, would be depleted from many areas of Karachi in near future. There is a need to understand the gravity of the situation for the city, and work out strategies with consensus with all the stake holders, more specifically with KW&SB, for future to make water sustainable for the people of Karachi. The first set up of illegal hydrant was near Sindh Industrial Trading Estate (SITE), Karachi, by drilling through KW&SB supply lines in 90s. The illegal hydrants business is being established and is a serious public nuisance and revenue loss to KW&SB. By the early 2000s, only a dozen illegal hydrants operated in Karachi, almost all of them thriving under the guise of underground boring. This changed dramatically in 2006 when the KW&SB supplied more water to its system and at the same time underground boring started extracting brackish water. Since this brackish water had higher than 500 milligrams of total dissolved solids per liter, industries stopped buying it because it could damage their products. This gave birth to another class of Water Mafia. The illegal operators just drill their way to the KW&SB's main pipeline and connect smaller pipes to it to fetch water to their industrial clients.

There are also major problems in water supply, one being that the infrastructure is putrefying and cannot withstand the demand for water, the deficient quantity of available water, and the quality and amount that each individual accesses on daily basis. Due to the increasing number of water infrastructure challenges expected in the near future for Karachi, which is very alarming to a city which is already disturbed for multiple factors, a solution must be devised. Therefore, some effective short-term and long-term solutions are required on urgent basis. Designing a resolution that meets rural and urban water demand is the objective of this article. The hypothesis is that if there is no change to the current water infrastructure and water policies for Karachi, there will be a shortage of water supply and increase in degradation of the water quality in the near future, due to a significant increase in the population.

The water governing agencies in Sindh have an obvious serious situation on their hands. It is very hard to maintain water systems in a city for a large population, and an infrastructure that is in serious need of repair. Most of this responsibility lies with the KW&SB. The role of the KW&SB is to ensure sanitation and health in connection with sewerage and the water supply for the city. KW&SB has a huge conveyance system of canals, tunnels, siphons and pumping stations, as well as water filtration plants in the city.

The KW&SB is in charge of 100 percent of the water supply, maintenance, and sanitation throughout the city. The real discrepancy or problem with this agency is that KW&SB distributes the deficient than

the required amount of water to the city to fulfill consumers' needs. Therefore, continuous water supply is not possible. Even intermittent water supply most of the time is difficult due to power failure at KW&SB pumping stations.In addition, Karachi faces so many problems regarding water distribution system. Presently, after water shut down from Hub dam, Karachi is being supplied only 550 million gallons per day (MGD) of water from River Indus, but requirement of the city is 1100 MGD according to World Health Organization (WHO) standards(54 gal/capita/day). That means Karachi gets almost 50% of its present requirement.

Another issue related to Karachi surface and groundwater is polluted water flow through these two rivers. The Lyari and Malir Rivers, which run through Karachi, are open drain to untreated industrial effluent because of negligence. These two rivers receive a large amount of effluent discharge approximately 450 MGD of raw municipal as well as industrial effluents to multi branched tidal creek estuary along the Karachi coast. It is revealed that after 1980, freshwater flow to the estuary has noticeably decreased, mainly due to the initiation of the industrial establishments at Malir and Lyari Rivers. Many studies investigated that various industries in Korangi site area, Karachi, also release effluents which cause water pollution to the area and eventually to sea water. Also, industrial water use is on the rise, and if this trend continues with the same pace without any recycling behavior, there will be drastic and irreparable damage to water resources in the near future. Recycling and reuse is practiced in most industries in the developed countries; and a growing number of developing countries are helping reduce the rate of consumption. More needs to be done. Therefore, there is need to recycle the bulk of wastewater Karachi generates, and it will be helpful for the people for Karachi to take advantage of this extra water for industrial or domestic use. Refer to Chapter 4 & 17 on waste water.

The climatic trends of Karachi have changed as has been indicated in many studies in the last few decades. For example extreme temperature for Karachi has shown decreasing (or no) trend for October and March, the months with increase in maximum temperature are February and December indicating an increase of 0.47 °C in temperature of both months. Minimum temperature follows a similar trend with an average increase of around 1 °C in December, October, November, January and February. Overall, Spring and summer seasons show a decreasing trend in maximum and minimum temperatures of the city with maximum decrease in maximum temperature as -0.59 °C in May and maximum decrease in minimum temperature of -0.71 °C also in May and June. Wind speed in Karachi shows a decreasing trend for summers, which might mean a decreased potential of wind power in the future since summer months have considerable wind speed to encourage wind generated electricity. The average annual precipitation of Karachi is 210 mm; however, there is a decline of 25% in the average amount since last few years. Overall, climatic trends show that there will be shortage of groundwater because of less recharge of groundwater due to lesser annual rainfall.

5.2.2 Brief - GKBWS Scheme K-IV Project Phase-I, 260 MGD

Presently Karachi is drawing water through approved quota of 1200 cusecs (650 MGD) water from Indus River / Kinjher Lake which is not sufficient to meet the present demand (1080 MGD) of the 20 million population of Karachi. The ever increasing water demand of Karachi needs allocation of another 1200 cusecs of water to meet the need for the next 20 year. The ECNEC has approved Phase-I of the project (260 MGD). K-IV Project at a cost of Rs. 25.551 billion and will provide a definite relief to the existing localities through augmentation of network at appropriate places.

K-IV Project is planned to be implemented in three phases as shown below:

S. No.	Phase	Capacity	Duration
1	K-IV Phase-1	260 MGD	2015 to 2018
2	K-IV Phase-2	260 MGD	2018 to 2022
3	K-IV Phase-3	130+ MGD	2022 to 2025

The socio-economic development in Karachi is very much linked on the timely implementation of K-IV Project. If this vitally nationally important project is delayed due to typical Government apathy, there is every possibility that Karachi may face water riots in future.

5.2.3 Brief - Greater Karachi Sewerage Plan (S-III)

The City of Karachi with an ever increasing population, currently around 20 million has been facing sever water crises being the lower riparian of Indus River System, and naturally, the KW&SB management remained focus in the past to bridge and minimize the gap between the supply and demand, which resulted in the accumulation of huge backlog in providing efficient sewerage services. In Karachi, approximately more than 400 MGD sewage is generated and due to inadequate sewerage network, most of the sewage is discharged untreated through 09 major nullahs / drains and 2 non perennial Rivers (Lyari & Malir Rivers).

KW&SB over the years, has constructed three Sewage Treatment Plants (STPs) having a cumulative design treatment capacity of 151 MGD, but due to system deficiencies, only 55 MGD is being treated, whereas remaining sewage escapes untreated, into the sea through Malir and Lyari Rivers.

S-III Project plans to construct Interceptors along Malir and Lyari rivers, laying new Trunk Sewers upto the respective Treatment Plants besides constructing new Sewage Treatment Plants and rehabilitating the existing three sewage treatment plants to enhance the overall treatment capacity of the city to around 470 MGD.

The discharge of treated wastewater into the sea will clean the beaches and sea front, besides protection and improvement of the city environment and maintain marine ecological balance. The option of re-cycling and re-using the treated effluent for non-domestic use is also being examined and studied under this project.

5.2.4 Recommendations

As a result of the increasing number of water supply issues expected in the near future for Karachi, a holistic solution must be devised. Designing a resolution that meets city's water demand, the following suggestions will be helpful for planning future endeavors.

- Water supply project such as K-IV input, approved in 2007, will increase the available water supply to the areas of Karachi. The K-IV project has three phases: Phase I 260 MGD, Phase II 260 MGD, and Phase III 130 MGD. It seems that sky rocketing rate of population increase and subsequently demand of water for the city leaves us with this prime solution that these phases for K-IV must meet the deadlines timely for smooth economic development of the city. It is also

important to mention that K-IV was launched before initiation of Bahria Town project. The water supply for Bahria Town is still unknown and there is no official request of water supply to KW&SB to date; however, it seems that the allocation of bulk of water from K-IV water supply project to Bahria Town will drastically affect the original water quantity to the city in future. Therefore, it is prerequisite that this city needs another water supply/source project for future.

- Development of small delay action dams are needed around the city for groundwater recharge and water storage for multiple usage.

- Use of rain water harvesting during monsoon season, as Karachi experiences heavy monsoon flooding few times during the year. It is recommended to make rain-harvesting devices mandatory for government buildings and to lower the cost of devices for consumers. This way, water can be collected on top of rooftops in tanks and then treated for public use. It is a low cost solution.

- Desalination is a major option that Karachi can take benefits from being at the coast of Arabian Sea. There is an abundance of sea water present that can be used. The development in desalination industry is appreciable; however, due to energy cost the desalinized water becomes very expensive commodity for a country like Pakistan. Therefore, what is needed that public and private sector should focus on developing indigenous cheap technology for energy consumption for desalination plants.

- It is estimated that 70% of the water that is distributed to Karachi is discharged as wastewater. The potential to recycle this water and reuse it for public demands is tremendous. This type of infrastructure can help meet the rising demand without extracting large amount of money in the provincial or federal budget, and it will help increase supply to the city and solve the urban problems. Similar to desalination industry, wastewater treatment also gets very expensive, and cost is almost two folds to the current price rate for commercial use. Therefore, finding cheaper solutions to wastewater treatment, with indigenous efforts of scientist and academia should be encouraged to save our wastewater going to sea.

- The rainwater harvesting and small scale recycling water plants will help solve the problem for the greater Karachi area residents.

- It is also recommended that a plan be devised for the rural sanitation problem. The approval and construction of these projects may take many years. However, the rural/underprivileged residents should be forced to obtain their water from the cheapest possible sources. These sources may include even sewerage recycling systems.

- Water metering to all kinds of consumers to earn revenue and save wastage of water

- Portable cheap water purification system can be implemented at a small scale; where traditional tea bags are filled with carbon granules and the outside contains biocides, which kill bacteria. The goal will be to have the provincial government supply the tea bags to the rural residents free of charge. This would help save many lives and decrease health related costs in the long run.

5.3 A historical review of Karachi water system and drainage

5.3.1 Dumlottee Wells

In the 19th century, Karachi was small fisherman's village situated on the left bank of Lyari River. This river remains dry through-out the year except during rainy spells when the rain water is drained out of

the city through it. Initially some shallow wells were dug on the river bank for supplying water to the Karachi Port.

In the later half of 19th century, the Karachi Municipality designed the first piped water supply system from the city which was commissioned in 1883. This scheme comprises of digging some shallow wells on the banks of Malir River in Dumlottee area which as about 19 miles from the main city. The well water was pumped into a 5 MGD capacity stone masonry gravity conduit which terminated at a 5.5 MGD capacity Reservoir. The capacity of the system was increased to 20 MGD in 1923 by adding more wells, a 15 MGD gravity conduit and two 6 MG reservoirs. The supply from this system now ranges between 2 and 5 MGD, whereas the requirement diverting un-filtered but chlorinated water from the Greater Karachi raw water conduit.

5.3.2 Hilaya Water Supply System

After establishment of a cantonment in Karachi during the 2nd World war, the city water demand increased beyond the then average daily supply of 15 MGD. The local administration, therefore, undertook implementation of the Hilaya Scheme for augmenting the city water supply by 20 MGD in two equal stages. The first stage was commissioned in 1943 and the second in 1953.This system originally drew water from an artificial lake known as the Haleji Lake having a surface area of 11 sq. Miles and a storage capacity of 3000 acre feet. Water gravitates from the lake through a masonry conduit upto two pump houses in Gharo, each of 10 MGD capacity. Two water treatment plants of equal capacity have been constructed in Gharo where complete treatment through sedimentation, rapid sand filtration and chlorination is provided. Potable water is brought to Karachi by an RCC pipe line where it is again boosted to a 20 MG capacity reservoir before distribution in the city. The water demand from this source has now increased to about 22-24 MGD. The additionalrequirement of 2-4 MGD is again being met by diverting unfiltered but chlorinated waterfrom the Greater Karachi raw-water conduit.

Haleji lake is presently being used as a standby source and the system drawswater from the Greater Karachi Bulk Water canal network.

5.3.3 Greater Karachi Bulk Water Supply System

Karachi was the first capital city of the country after its birth in 1947. It alsobecame the most important industrial and commercial centre. The older system of watersupply could not cope up with the growing demand. In order to meet shortages in supplyand to cater to future demands of the expanding city, the Greater Karachi Bulk WaterSupply Scheme was designed in 1953 for supply of 280 MGD potable water to the city.On the basis of a population projection of 3 million by the year 2000, the schemewas designed and divided into four equal phases, each of 70 MGD. It comprises of opencanals, covered conduits, a tunnel, siphons, pumping stations, mains and draws waterfrom the Kinjhar Lark.

1stPhase:

The first phase of the scheme for bringing 70 MGD Kinjhar Lake water to the citywith raw-water pumping at Dhabeji, a 70 MGD water treatment plant at COD Hills, Karachiand complete water conveyance system comprising of a 280 MGD lined canal, a conduit ofequal capacity up to Pipri and of 140 MGD capacity up to Karachi, a 10 MG reservoir atCOD Hills along with the distribution net-work was started in 1954 and completed in 1961at a total cost of PKR 185 million.

2nd Phase:

Contracts for the 2nd phase works were awarded in 1969. The main works includedconstruction of a 70 MGD pump house at Dhabeji, laying of 84” dia pre-stressed pipesiphons a 25 MGD pump house at =

pipri and two water treatment plants of 25 and 45MGD along with 10 MG reservoirs at Pipri and COD Hills respectively. Some additional truckmains were also laid for improving the distribution system. The 2nd phase works werecompleted in early 1971 at a total cost of PKR 200 million.

3rd Phase:

The 3rd phase works were taken up in 1975 and were commissioned in 1978. Theworks completed under this phase include construction of a 70 MGD pumping station atDhabeji, two pumping stations along with water treatment plants of 25 MGD capacity eachat North East Karachi and Pipri, 84" dia pipe syphone, three balancing reservoirs and thedistribution mains. Total cost of these works in PKR 750 million. A reservation for supply of22 MGD of un-filtered water to Karachi Steel has also been made under this phase.

4th Phase:

Due to financial constraints, 4th Phase works have been divided into two parts.Under stage I, improvement of lined canal, modifications of the present Dhabeji PumpingStations, laying of 84" dia pipe syphons, construction of a 25 MGD pump house andclarification units at Pipri, improvement of the secondary distribution net-work andinstallation of domestic meters in K.D.A. Scheme No.1 & 5 have been taken up with theWorld Bank assistance and are due for completion by June, 1987. After completion ofthese projects at a total cost of PKR 360.0 millions the city water supply will be augmentedby 50 MGD.

Hub Water Supply System:

A 151 ft. high and 21,000 ft. long earthen dam has been constructed by WAPDAon Hub River for creating a reservoir or almost one million acre feet storage capacity formeeting the agricultural and industrial water supply requirements of Baluchistan and forsupply of 89 MGD water to Karachi for domestic use. The quality of Hub Water iscomparable to Indus water and therefore, similar parameters for pumping and treatmenthave been adopted. The project has been designed for completion in two stages. Stage-Iworks which comprise of a 90 MGD pump house, two steel pressure mains one 20 MGreservoir, trunk mains and primary treatment of lake water by screening and chlorinationwere completed and commissioned in August, 1982 at a total cost of PKR 266 million,Stage-II works, which comprise of improvement of secondary distribution net-work andconstruction of a 90 MGD water treatment plant, will be taken up after the required fundare made available by the Govt.

5th Phase of Greater Karachi Bulk Water Supply Scheme:

A master study for identification of water supply requirements of the cityduring short, medium and long term plans (upto 2025) and for preparing feasibilitystudies, including costing of projects during various plan periods have been assigned to aconsortium of consultants. Implementation actions on the consultants proposals will betaken after their approval by the Board and after allocation of funds by the Govt.

5.3.4 Monitoring and Controls

Laboratory facilities have been provided at all water treatment plants formonitoring chemical dozes and maintaining quality controls according to WHO standards.In addition KW&SB Central Laboratory at COD Hills Filter Plants monitors the quality ofcity water by collection and testing about 1000 samples per month from the distributionnet-work. The Laboratory reports indicate that the chemical and bacteriological quality ofcity water is within the prescribed WHO limits. However, isolated cases of contaminationare being reported which are promptly attended by the KW&SB distribution engineers forensuring that the city water remains un-contaminated and bacteria free.

During various studies conducted by us on the quality of city water. We observedthat the following factors mainly cause contamination in the distribution network:

i. Intermittent water supply due to general shortage of water.

ii. Leakages in water supply mains which have out-lived their effective life orhave not been laid in accordance with the required specifications, resulting ininfiltration of contamination ground water during non-supply hours.

iii. In-discriminate disposal of raw-sewage and inadequate of defective seweragesystem in the city.

iv. Installation of un-authorized suction pumps on water main by un-scrupulouselements for augmenting their water supply.

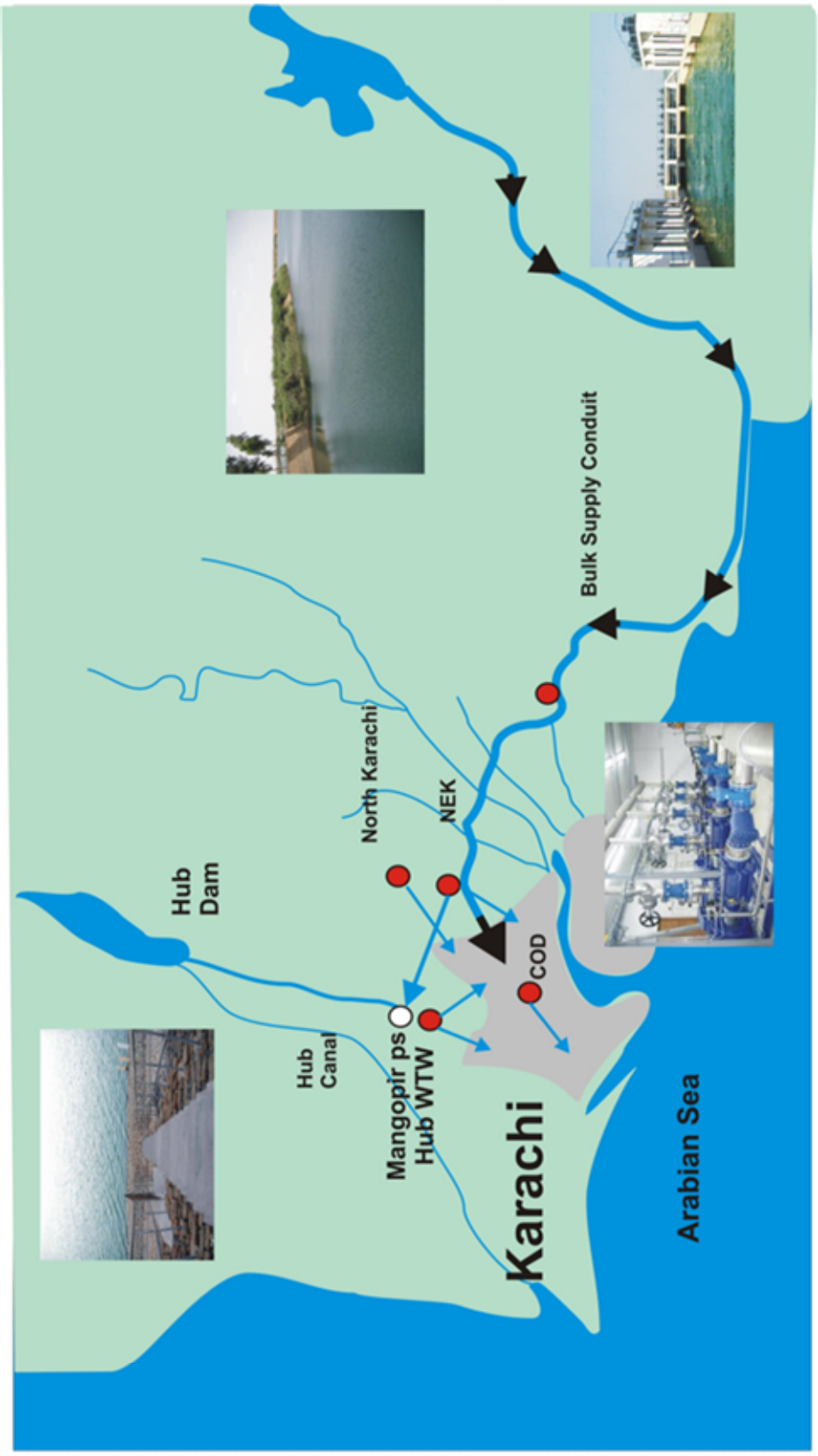
v. Consumption of well water in the city.

vi. Sub-standard construction of water storage tanks and sewerage system atindividual premises.

5.4 Appendices

1. Principal Water Routing for Karachi
2. Karachi Water supply system (Existing & Proposed).
3. Conceptual plan for a realistic sewerage disposal system for Karachi.

Principal Water Supply Facilities in Karachi



Appendix-2

KARACHI WATER SUPPLY SYSTEM

EXISTING AND PROPOSED

DISTRIBUTION SCHEDULE FOR 28 MGD

LANDHI KORANGI INCLUDING BOTH RESIDENCIAL AND INDUSTRIAL	5.00	M.G.D
DEFENCE COOPERATIVE HOUSING SOCIETY	2.00	M.G.D
MALIR AND SAUDABAD KHOKRAPAR AND MODAL COLONY	2.50	M.G.D.
KORANGI CREEK P.A.F. BASE	1.00	M.G.D.
THERMAL POWER STATION IBRAHIM HYDRI	1.00	M.G.D
SHAH FAISAL COLONY EPZA SHAH LATIF TOWN CIVIL AVIATION & PIA	1.50	M.G.D
LYARI	3.00	M.G.D
OLD CITY AREAS	5.00	M.G.D
CLIFTON GIZRI SHIRIN JINAH COLONY KEMARI BHUTTA VILLAGE AND K.P.T.	5.00	M.G.D
LINES AREA TRADE & FINANCE CENTRE	1.00	M.G.D.
PAKISTAN RAILWAYS KESC AND OTHERS	1.00	M.G.D.
TOTAL	28.00	M.G.D.

100 MGD DISTRIBUTION

30 MGD ------ SCH 33 45 & NK
30 MGD ------ SCH 36 24 UNIVERSITY COD & MALIR CANTT etc.
40 MGD ------ CITY DISTRIBUTION SYSTEM (Rs 384.25 Million)

BULK WATER SUPPLY SOURCES

A	INDUS SOURCE		
	1. G.K.B.W.S.S	Phase I	70 mgd
		Phase II	70 mgd
		Phase III	70 mgd
		Phase IV	70 mgd
			210 mgd
	2. HALEJI		20 mgd
B.	HUB DAM SOURCE		89 mgd
C.	DUMLOTTEE WELLS		5 mgd
	TOTAL BULK WATER AVAILABLE		324 mgd

50 mgd works by K.D.A
28 mgd suppl works by march 89 (28 + 42)

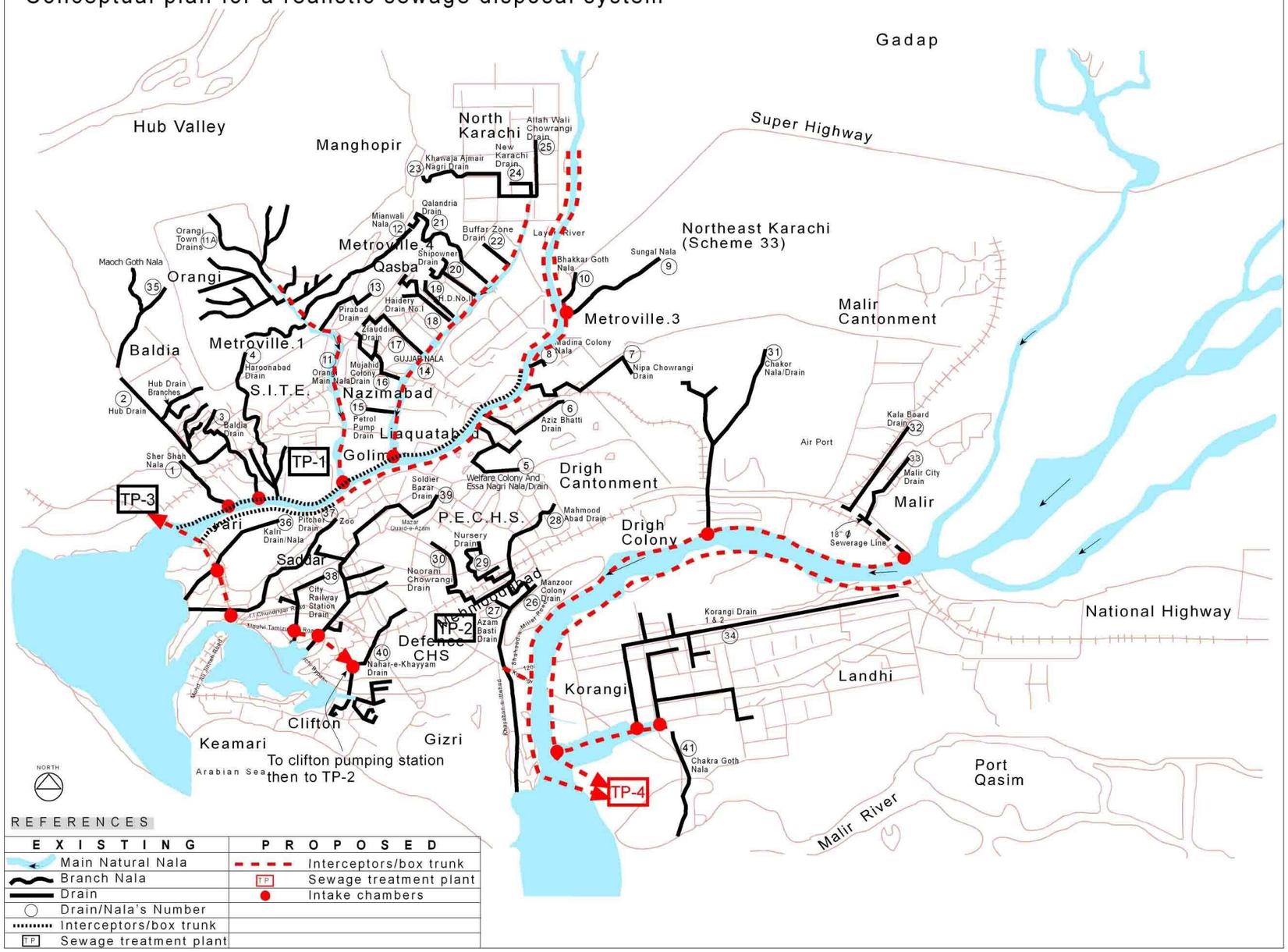
DHABEJEE PUMPING STATION

1st PHASE		
DIESEL ENGINES	5 NOs	2 NOS 72" Ø PRESTRESSED RISING MAINS
CAPACITY	120 M G D	
OPERATION	72 M G D	
2nd PHASE		72" Ø M.S.RISING MAIN
ELECTRIC PUMPS	5 NOs	
CAPACITY	120 M G D	
OPERATION	72 M G D	
3rd PHASE		
ELECTRIC PUMPS	5 NOs	3rd PHASE RISING MAIN 72" Ø
CAPACITY	120 M G D	
OPERATION	72 M G D	4th PHASE RISING MAIN 72" Ø

Appendix-3

Karachi map showing the documented natural nalas & drain (which are the main disposals for sewage and rain water) and the integration of these with the mains & STPs.

Conceptual plan for a realistic sewage disposal system



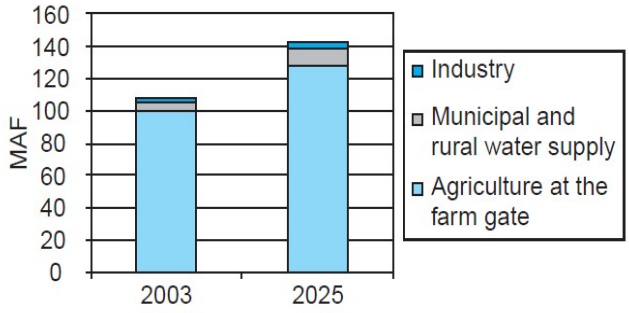
REFERENCES

EXISTING	PROPOSED
Main Natural Nala	Interceptors/box trunk
Branch Nala	Sewage treatment plant
Drain	Intake chambers
Drain/Nala's Number	
Interceptors/box trunk	
Sewage treatment plant	

S.NO.	NAME OF DRAIN/NALA	LENGTH (rft)
	Nalas/drains no 1 to 25 dispose into the Lyari Nadi and then into the sea.	
1.	Sher Shah Nala	6603
2.	Hub Drain + Branches	36438
3.	Baldia Nala/Drain	15715
4.	Haroonabad Drain	25980
5.	Welfare Colony And Essa Nagri Nala/Drain	16671
6.	Aziz Bhatti Drain	13856
7.	NIPA Chowrangi Drain	15588
8.	Madina Colony Nala	1000
9.	Sungal Nala/Drain	8660
10.	Bhakkar Goth Nala	3565
11.	ORANGI NALA MAIN (Orangi to Lyari River)	38250
11A.	Orangi Town Drain/Nala 16 Branches	94234
12.	Mianwali Colony Nala	11256
13.	Pirabad/Muslimabad Drain	5550
14.	GUJJAR NALA	40000
15.	Petrol Pump Drain	3350
16.	Mujahid Colony Drain	12500
17.	Ziauddin Hospital Drain	7000
18.	Haidary Drain - I	8000
19.	Haidary Drain - II	7600
20.	Shipowner College Drain	6570
21.	Qalandaria Drain	17200
22.	Buffar Zone Drain	1500
23.	Khawaja Ajmair Nagri Drain	19000
24.	New Karachi Drain	2500
25.	Allah Wali Chowrangi Drain	10500
	Nalas/drains no 26 to 34 dispose into the Malir Nadi and then into the sea.	
26.	Manzoor Colony Drain	11700
27.	Azam Basti Drain	1750
28.	Mahmoodabad Drain Main	13480
29.	Nursery Drain (Branch M.D.)	6975
30.	Noorani Chowrangi Drain (Branch M.D.)	15950
31.	Chakor Nala/Drain	23080
32.	Kala Board Drain	9310
33.	Malir City Drain	9959
34.	Korangi Drain 1 & 2	48496
	Nalas/drains no 35 to 41 dispose into the back water and then into the sea.	
35.	Maoch Goth Nala	23500
36.	Kalri Drain / Nala	94234
37.	Pitcher Drain	12124
38.	City Railway Station Drain	10825
39.	Solder Bazar Drain + 4 Branches	40000
40.	Nahar-e-Khayyam Drain	5629
41.	Chakra Goth Nala	7000

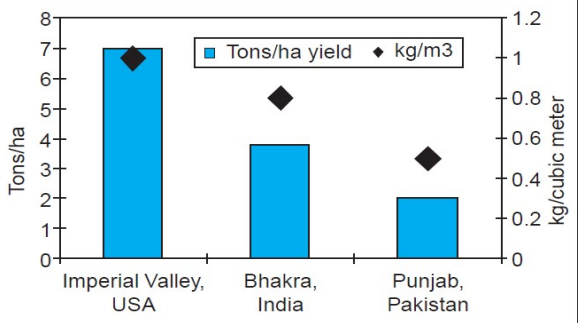
Dated: September 2006

Fig. 3.11: Projected demand for water



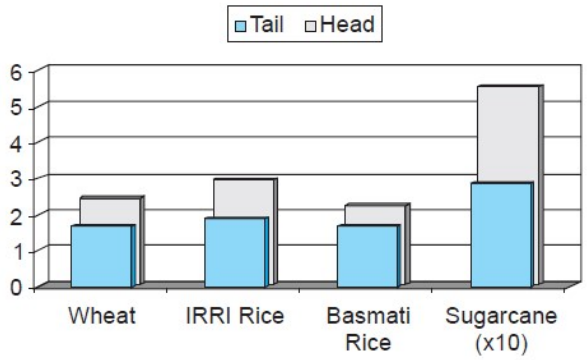
Source: Hasan, 2005.

Fig. 3.12: Wheat yields per unit of land and water



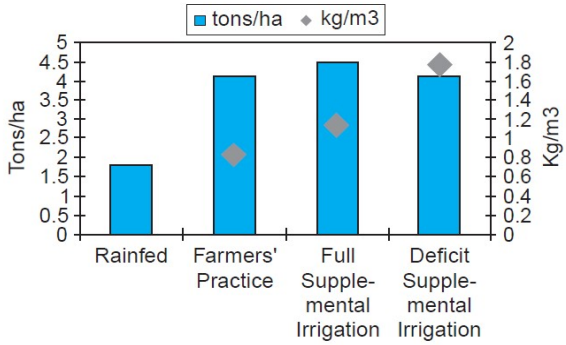
Source: Ahmad, 2005.

Fig. 3.15: Crop yields for head- and tail-enders



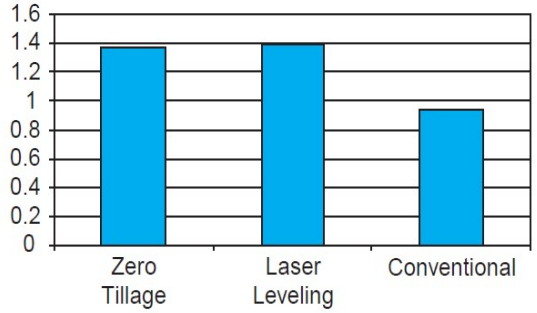
Source: Qureshi, 2005.

Fig. 3.18: Yield and water productivity of wheat under different irrigation scheduling strategies



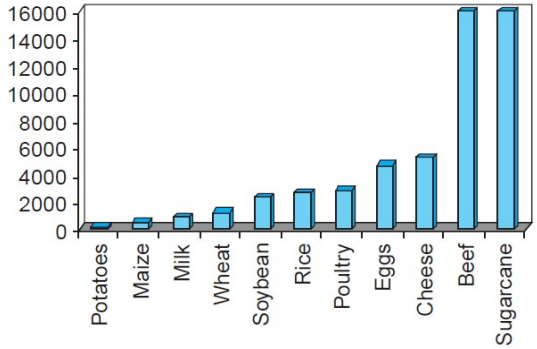
Source: Ahmad, 2005.

Fig. 3.19: Production (kg/cubic meter of water) under different agricultural practices



Source: Amir, 2005.

Fig. 3.20: Cubic meters of water to produce a ton of produce

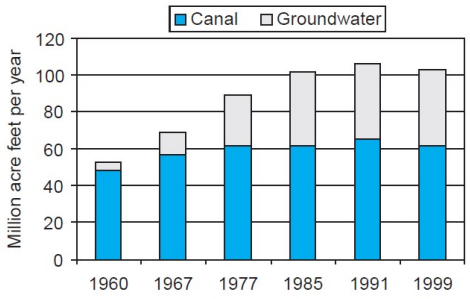


Source: Hoefstra, 2003.

Courtesy: "PAKISTAN'S Water Economy Running Dry" (John Briscoe • Usman Qamar)

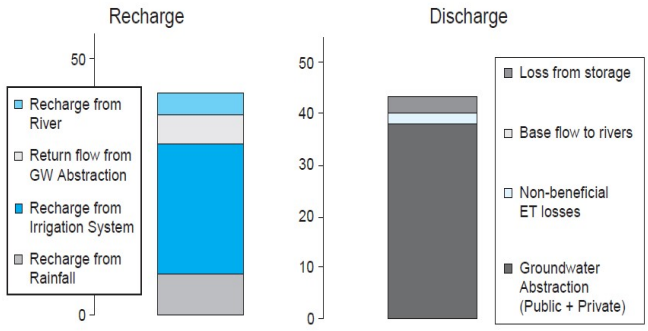
Appendix: Comparison of Indus Basin with other regions.Benefits of new storages.

Fig. 3.23: The growing role of groundwater irrigation



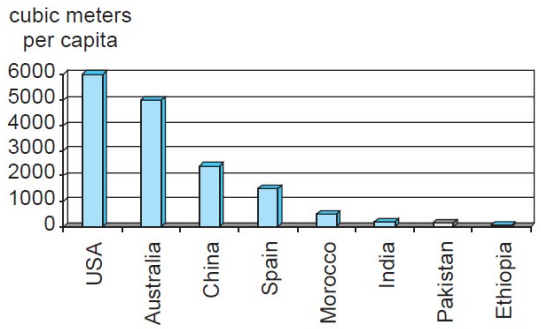
Source: Steenbergen and Gohar, 2005.

Fig. 3.24: Punjab water balance: normal year (MAF)



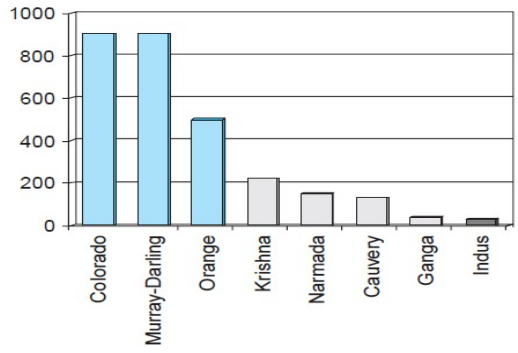
Source: Steenbergen and Gohar, 2005.

Fig. 3.42: Storage per capita in different semi-arid countries



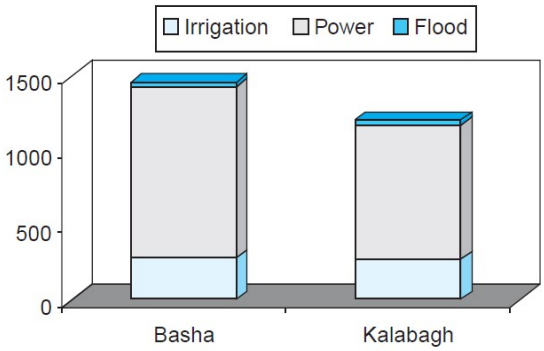
Source: The World Bank analysis of ICOLD data.

Fig. 3.43: Days of average flow which reservoirs in semi-arid countries can store in different basins



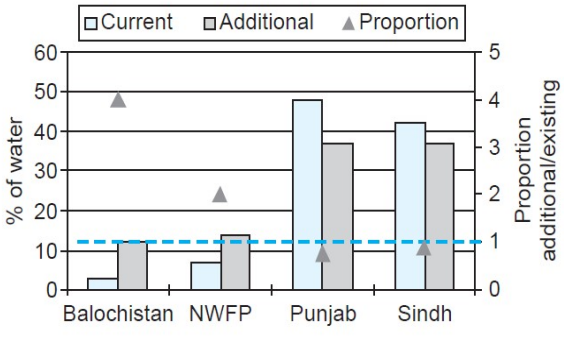
Source: The World Bank analysis of ICOLD and GDRC data.

Fig. 3.46: Benefits from Basha and Kalabagh



Source: Amir, 2005.

Fig. 3.49: Who benefits from new Indus storage?



Source: Water Accord and Bank Staff.

Courtesy: "PAKISTAN'S Water Economy Running Dry" (John Briscoe • Usman Qamar)

6. THE CLIMATE CHANGE DEBATE

Suleman Najib Khan… (initial description adapted from a French COP21 document)

The 1992 Earth Summit was the start of global climate negotiations. In the last +20 years the world began to hear the mantra about greenhouse gases (GHG) about global warming, earth's ozone layer dissipation etc. in the realm of climate change. No doubt burning of all hydrocarbon fuels emitted Carbon dioxide (CO_2) which was clearly the most abundant GHG. The other being Methane (CH_4), Hydrofluorocarbons (HFC), Nitrous oxide (N_2O), Perfluorocarbons (PFC), Sulphur Hexafluoride (SF_6) and Nitrogen Trifluoride (NF_3). The first six GHG were targeted by the Kyoto Protocol signed in 1997 requiring a 5.2% cut back by 2012. The Kyoto Protocol came into force in 2005.

In late November 2015 the 21st conference on climate change known as COP21 meaning 21st Conference of Parties will take place in Paris, France. The agenda will include the impact of human activities. The emission per head of population of the main GHG emitting countries (in 2011) will be discussed. Implementation solutions through GHG targets will be developed and implemented. This COP21 / CMP 11 is the twenty-first Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCC) and the eleventh meeting of the Parties to the Kyoto Protocol.

At the international level, the Intergovernmental Panel on Climate Change (IPCC) was created in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). What can we all do for mitigation of the negative influences of climate change?**A Paris Climate 2015 Special document issued by France states the following objectives:**

1. Not to allow more than 2°C temperature rise compared with the pre-industrial era.
2. By building a house with a wooden framework some 15 tonnes of CO2 emissions could be saved.
3. Reduce fossil fuel consumption (coal, oil, gas), control energy consumption(energy efficiency of products and low-carbon economy). Develop the use of renewable energies etc.
4. In industrial production, promote processes with lower GHG emission, etc.
5. Encourage the use of low-carbon vehicles.
6. Waste and water treatment. Manage the quantities of waste and capture methane emissions etc.
7. Renovate the existing stock and build new energy efficient buildings etc.
8. Limited use of nitrogen fertilizers in agriculture and promote mechanization, etc.
9. Only use wood from sustainably managed forest etc.

Adapt policies with the purpose to reduce vulnerability to the impact of climate change. The consequences of climate change are floods, fires, soil instability etc. This case of renewable sources ofenergy are the most important technological changes that can help us reduce GHG emissions. The main impacts of climate change due to global warming are the following:

1. The sea level is rising. Between 1870 and 2000 the sea level rose 18 cm globally. One third of this rise (6 cm) was in the last 20 years. By 2100 the average sea level could rise between 26 cm to 82 cm. This rise in sea level will affect islands, deltas and very low lying coastal area such as Bangladesh, the Netherlands, etc. However the sea water intrusion claimed by the anti-dam lobby in Pakistan as an argument against building dams on the Indus Basin is looking at a wrong cause. Since the rise in sea level is cause by melting of ice in the Arctic and Antarctic circles there can be only an advantage in building inland dams. Reservoirs allow 12 months regulated flow in the rivers. In the monsoon flood season the flows keep sea water inland intrusion in complete check. A regulated flow in the rivers for all 12 months with the help of reservoir storages is the solution.

2. Rise of CO_2 emissions in the atmosphere means greater absorption of CO_2 by the oceans. Consequently sea water become more acidic as CO_2 is changed into carbonic acid on contact with the sea water. Between 1751 and 2001 the pH of the surface waters of oceans fell from 8.25 to 8.14. This acidification represents a major risk for coral reefs and threatens numerous ecosystems.
3. Animal species, specially migratory birds are moving northwards as the winters in the northern hemisphere become warmer. Certain insects are reducing in numbers due to higher temperatures.
4. The life cycles of plants are speeding up and harvesting is taking place earlier.

6.1 Renewables

The broad description on renewables includes hydrology/ hydropower, wind power, solar PV power and to small extent even some categories of biomass. Pakistan is one of the nine countries in the world that can generate more than 50% of its electrical energy needs from the hydro resource. This means from dams of all sizes (depending on the size of the river). Also from the run of the river hydropower projects (abbreviated HPP). Hydropower must take precedence over all other renewable energy resources.

6.2 Global Warming/ Glacier Retreat

Glacier retreat is a reality for which Pakistan has done no visible groundwork, inspite of the fact that our rivers are primarily glacier fed. In Paris at the COP21 it is expected that some limits will be imposed on fossil fuels after 2020, in an attempt to limit CO2 a major GHG thought responsible for Global Warming.At present there is a rush to install more coal plants worldwide. The following chart is educative:

Table 1: Key indicators for 1993, 2011 and 2020

Source: 1993, 2020 figures from Energy for Tomorrow's World (WEC, 1995). 2011 figures from World Energy Resources (WEC, 2013). Other renewables 2020 figure from World Energy Scenarios report (WEC, 2013)

	1993	2011	2020	% Growth 1993–2011
Population, billion	5.5	7	8.1	27%
GDP				
Trillion USD	25	70	65	180%
TPES Mtoe	9 532	14 092	17 208	48%
Coal Mt	4 474	7 520	10 108	68%
Oil Mt	3 179	3 973	4 594	25%
Natural Gas bcm	2 176	3 518	4 049	62%
Nuclear TWh	2 106	2 386	3 761	13%
Hydro Power TWh	2 286	2 767	3 826	21%
Biomass Mtoe	1 036	1 277	1 323	23%
Other renewables* TWh	44	515	1 999	n/a
Electricity Production/year				
Total TWh	12 607	22 202	23 000	76%
Per capita MWh	2	3	3	52%

Appendix-I

THE WATER ISSUES IN THE CITY OF LAHORE

Courtesy of LCCI, R&D Section

Water Consumption in Lahore by Different Sectors:

The domestic, industrial, commercial and institutional sectors in the city are totally dependent on the groundwater to meet their water needs. Agriculture sector relies partially on surface water in addition to groundwater. Existing groundwater abstraction for various sectors is estimated about 7.18 million cubic meters per day (MCM) as shown in the table given below:

Existing Groundwater Use in Lahore (MCM/Day)

Sector	Water Use MCM/Day	% of Total	Remarks
Domestic	3.79	52.79	490 WASA TWs and 240 PTWs
Industrial	0.92	12.81	4,000 small TWs
Commercial	0.77	10.72	Private TWs in the sector, around 1000 small TWs
Agriculture	1.70	23.68	Around 10,000 PTWs around City
Total	**7.18**	**100.00**	

Perusal of the above table shows that around 53% of groundwater is used for domestic needs whereas industrial and agricultural use are about 13% and 24% of the total pumping.

Increasing Pressure on the Aquifer:

Currently, WASA is providing its services to around 6 million people in the city of Lahore. This number is expected to increase to 9.0 million in 2030. Accordingly, the current demand of around 1985 MCM/year (year 2013) will increase to around 3,200 MCM/year in 2030. To meet the above mentioned demand, it is expected that:

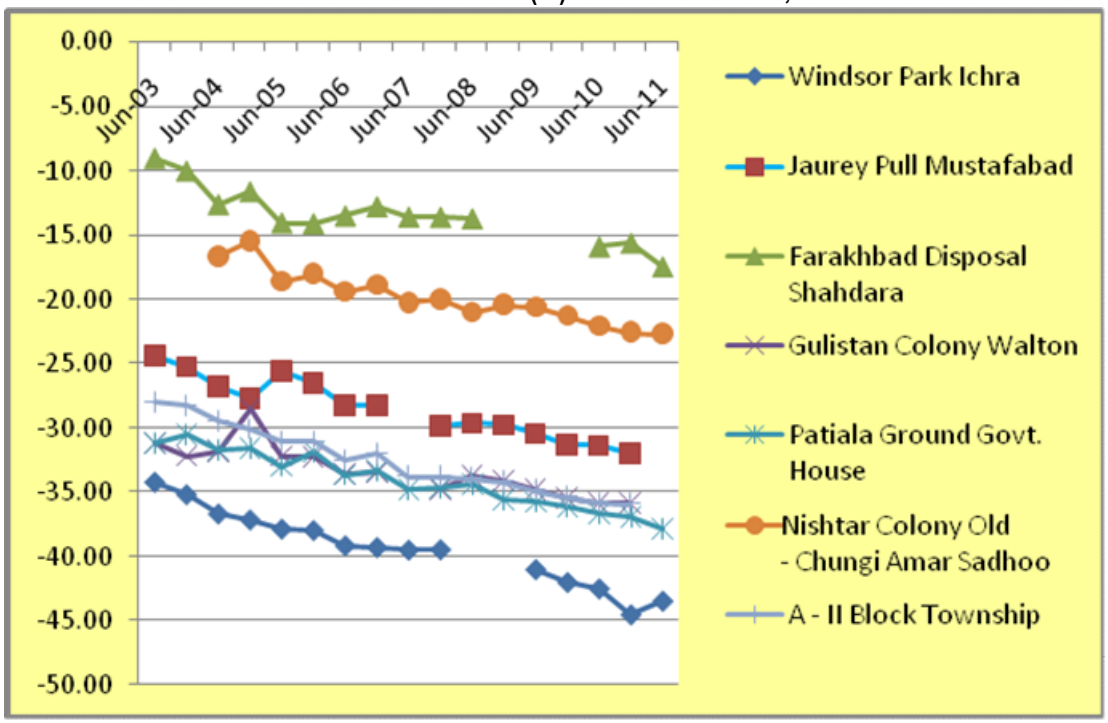
- WASA would have to install more than 350 additional tubewells; and
- Similarly the Non-WASA tubewells are expected to increase to more than 430 from the current number of around 240.

Intensive Pumping & Declining Water Table:

As a result of intensive groundwater pumping the groundwater level has shown a continuous declining trend in the last 20-30 years. Depth to groundwater levels ranges from about 15m neat the river to more than 40 m in the central parts of the city. On average, the water table is depleting by 2-3 feet every year. This continuous decline

in groundwater level has created a cup shaped depression under the Lahore City - and the matter needs attention to expand the "well field and increase groundwater recharge facilities – as recommended in the number of studies carried out in the past. Based on the field data collected by WASA – the trends of GWL in various parts of the city are shown in the figure given below.

Groundwater Levels (m) - WASA Tubewells, 2003 – 11



Perusal of the above figure shows that groundwater levels have shown a continuous decline - all over the city and are already more than 40m below ground surface in the central parts of the city. It has been estimated that by 2025, water table in majority of the city would drop below 70 meters. By 2040, the water table is expected to drop below 100 meters – the situation demands due attention.

Threat to Groundwater Quality:

Previous investigations by WAPDA /WASA and other agencies indicate that groundwater quality in Lahore city is generally fresh (historically being close to the Ravi River) - whereas it is brackish to saline in the southern part of the city towards – Raiwind and Kasur. This – ever increasing cup shaped depression in groundwater levels will induce movement of saline groundwater from the southern areas – resulting in another problem for

A recent study has been *carried out by JICA*, "The preparatory study on Lahore water supply, sewerage and drainage improvement project in Islamic Republic of Pakistan 2010". JICA carried out the assessment of the existing conditions, identification of the constraints and developed an action plan for 100 % coverage for water and sanitation by 2035. The major problems identified by JICA study for water supply in Lahore are as below:

Viewpoints	Issues
Water quantity	• Increasing water demand • Decreasing groundwater level • Serious Unaccounted water loss
Water quality	• Increasing arsenic concentration • Contamination in the pipelines

Points needing attention:

Continuous decline of water levels and intrusion of saline groundwater will result in reduction in the availability of pot able water for domestic use and industrial sector. Some of the major factors are as below:

- Rapid urbanization of the city whereby the green belts have been replaced by industries and housing societies has badly affected the recharge of groundwater and also resulted in depletion of the water table.

- The average recharge to the groundwater in the city is estimated to be 6.5 MCM/day, of which 82% is provided by River Ravi, 12% by rainfall/canal system and remaining 6% by return flow from irrigation fields. The difference between recharge and discharge is estimated to be 0.67 MCM/day. Since the discharge is higher than the recharge, there is constant depletion in the water table;

- The main water related problems that can be faced by the industry in near future are the water availability and deteriorating quality of surface/ground water. The main industries in the city of Lahore are textile, pharmaceutical, electronics, leather, sugar, food and beverages. These industries have high water demand and are at considerable risk due to any sort of water scarcity in the future and deterioration in groundwater quality.

Waste Water Problem:

Around 8.0 million cubic meters per day (MCM/day) wastewater is generated in the city of Lahore and goes into the Ravi River without any treatment. According to some other estimates, wastewater generation in the city is 231 liters per capita per day. This puts in danger the huge population that consumes vegetable and fruits from the areas irrigated by contaminated water. Arsenic and Fluoride contamination have already played havoc in some of the areas. In future the major threat will be the pollution dragon hanging around and needing our attention.

Way Out

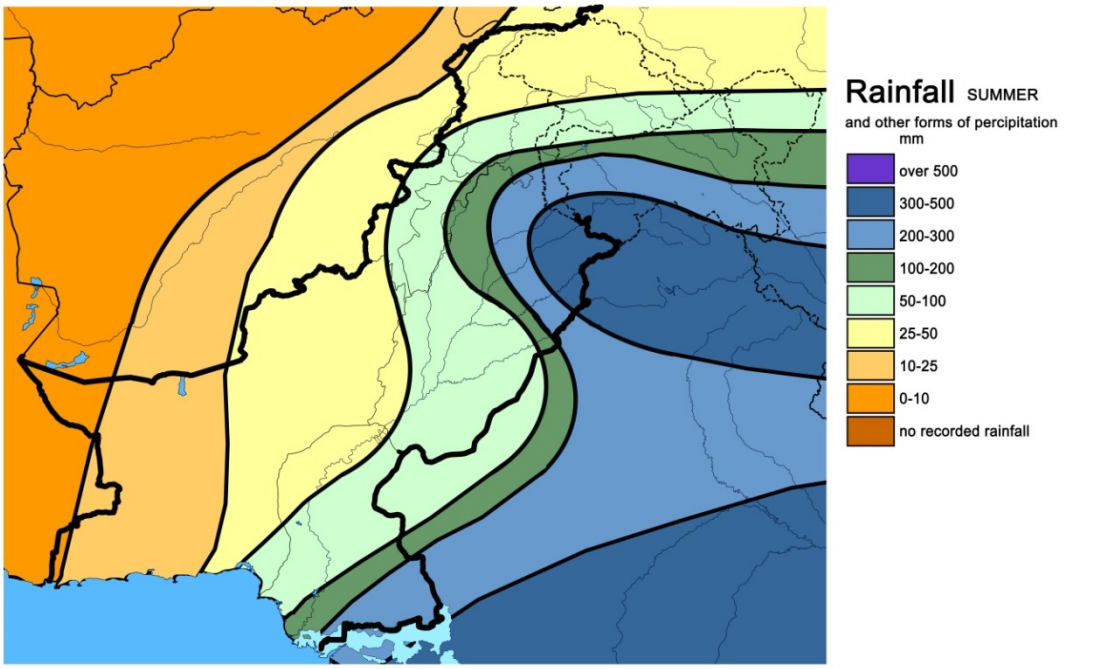
Declining water levels, increasing threat to the groundwater quality due to lateral movement form the south and pollution due to the unchecked discharge of industrial, sewerage waste need to be given due attention.

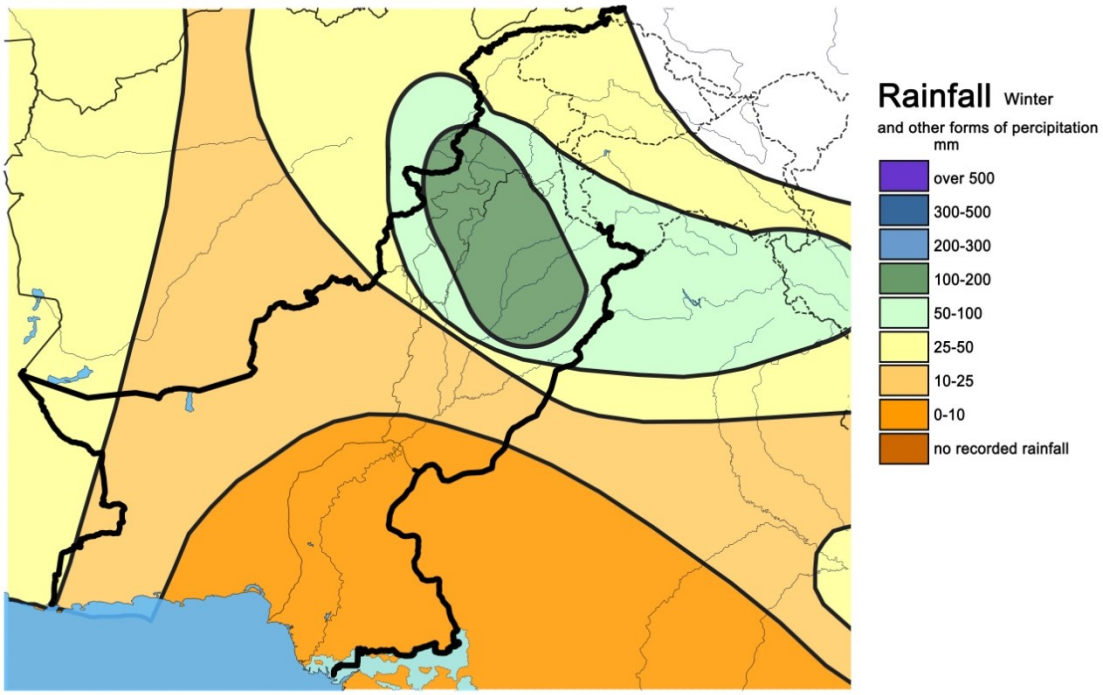
We should lay more emphasis on:

- Ensuring the sustainability of water for domestic and industrial requirements - quantitative and qualitative aspect through expansion of well field and finding the ways towards increasing groundwater recharge ; and

- Treatment of wastewater and its reuse in some sectors such as car washing, some cooling industries and other business sectors – including irrigation for selected crops – Industrial Sector has to come forward to help the public agencies.

Appendix-II Variation of Precipitation during Summer & Winter (average annual rainfall 25 MAF)





Note: Pakistan is a semi-arid land. The monsoon rains do not normally go beyond and higher than the Besham area. Bulk of the Indus Basin rivers are basically glacier fed.

7. THE GRIEVOUS BETRAYAL

Dr. Hon. Shams ul Mulk

The natural resources that Pakistan has been blessed with, makes it literally immune to electric power shortages, seasonal shortages of water for agricultural crops, and floods damages to life, property, crops, and social & economic infrastructure. And yet, the people of Pakistan witness these three evil spectacles so often that they have become a part of their daily miseries. These people did not deserve to suffer these miseries at any time, but definitely not in the first decade of a century, called the era of Asia. Because only a few decades earlier (1960s and early 1970s) Pakistan was touted as an emerging Asia's Tiger. Faiz expresses such anguish in his incomparable style used for such situations:

یہ داغ داغ اجالا ، یہ شب گزیدہ سحر
وہ انتظار تھا جس کا ، یہ وہ سحر تو نہیں

یہ وہ سحر تو نہیں ، جس کی آرزو لے کر
چلے تھے یار کہ مل جائے گی ، کہیں نہ کہیں

This stain covered daybreak, this night-bitten dawn,
This is not that dawn of which there was expectation,

This is not that dawn with longing for which
The friends set out that somewhere there would be met with.

The explanations given for the current situation are many, including diagnoses and prescriptions. But what is absent from all such analyses is the truth, mostly due to lack of relevant information or background, but deliberately in some cases especially the vested interests. In fact we are faced with a famine of truth in Pakistan. Bereft of the divine light of truth, what is left is bottomless darkness that envelops everything including routes to safety. The current Government (the Government of 2008 – 2013) inherited the problem, and that must be recognized in its defence. However, in the four years of its tenure, it has not inched towards an improvement, but taken gigantic steps towards deterioration. But such an argument, if pursued all the time, will bring in almost every ruler and leader of Pakistan in the preceding two to three decades in the list of those responsible, partially or totally for the current mess. What are the facts and realities. Let us begin with a summarized version of an eventful journey from its beginning i.e. August 1947, the establishment of Pakistan.

Post colonial world of the mid-twentieth century was brimful with aspirations for economic growth; Pakistan was no exception. With the major part of the world famous Indus Basin having become part of Pakistan, it inherited a very extensive infrastructure of irrigated agriculture. However, the irrigated agriculture was subsistence level because of very uneven water supplies during cropping seasons. The average flows in Indus River in the six summer months averaged at 115 Million Acre ft (MAF) (83% of total); and the flows in the six winter months arranged at 23 MAF (16% of the total). The need for productive growth of the crops were on the other hand averaged at 70 MAF for the summer crops and 35 MAF for winter crops. There was an annual surplus in summer (115 – 70 = 45 MAF) and shortage in winter (23 – 35 = (–) 12 MAF). This water shortage in winter, which extended to early kharif and later kharif also, resulted in sub-optional crops yields, in some cases, the world's lowest yield per acre. Moreover, the problem of water-logging and salinity had started showing its crippling potential; so much so, that by the end of first decade of independence, Pakistan was losing one hundred thousand acres of productive agricultural land due to this twin menace every year. Per-capita electric power generation

was a barometer for economic well-being, but with only 62 Mega Watts (MEGAWATT) of total generation capacity, Pakistan (the then West Pakistan) was hopelessly deficient in this area. Historically, Indus Basin has been highly vulnerable to floods. The floods of 1950 were fresh in the memory of people and the Government. Such floods inflict unbearable damages to life, property and social and economic infrastructure. Pakistan's development strategy was thus aimed at:

- Eliminating irrigation water shortages to enable practice of productive irrigated agriculture, and to expand irrigated area to provide for increasing population.

- To generate large chunks of electric power for agricultural, industrial and domestic needs.

- To construct flood control infrastructure.

Wheel did not need to be re-invented for implementation of the national development plan based on the above. The technology used thousands of times in the 20th century had shown that all the three core needs of Pakistan could be fulfilled by the construction of multipurpose large dams at appropriate sites in the Indus rivers system, such dams that would create large reservoirs, capable of

- storing floods water, releasing it in lean water months for agricultural needs.

- generating huge quantities of electric power at low cost.

- reducing the peaks of major floods and providing the needed flood relief.

Mangla Dam was a part of Indus Waters Treaty, but Tarbela Dam was a multi-purpose project to achieve the three core-purposes described above. If any re-affirmation of this strategy was needed, it came in the form of "Water and Power Resources of West Pakistan – A Study in Sectoral Planning", which was a report prepared by the Indus Special Study team of the World Bank in 1967. This exercise was conducted on a special request of Pakistan to the World Bank made in 1963 by President Ayub Khan in person to the President of World Bank for preparing Pakistan's development route after completion of Tarbela Dam. This study was one of the most comprehensive exercise ever undertaken by the World Bank for a river basin. In the words of the Bank "it will serve as an indispensable model for engineers, economists, and planners for years to come". The Report concluded that Pakistan (West) would need another large reservoir by 1992, and suggested that Kalabagh Dam (KBD) should be the project to meet this purpose, followed by Bhasha Dam. It was also suggested that while these two dams would be under construction, one after the other, Pakistan would have the time to concurrently carry out detailed survey, investigation and studies of the Indus rivers to select future projects and their sequencing. While preparing detailed project plans, WAPDA scheduled completion of KBD by 1995, and of Bhasha by 2010. WAPDA initiated also feasibility studies for Kalabagh Dam, and geological mapping of Bhasha Dam.

But all this went in vain. The suggested plan was thrown in the waste-paper basket on the plea that there was no national consensus on construction of Kalabagh Dam. The opponents of the Kalabagh Dam proposed that it would be better to identify alternatives of Kalabagh Dam. For twenty years, the search for acceptable alternatives has been pursued, and this search has led Pakistan to a gloomy darkness of electricity load-shedding, closure of factories, damages by floods, and relentless disputes between the provinces on sharing of Indus Rivers Water. In the hind sight it appears that the rulers wanted electricity shortages 80 that the worst alternative (generation by furnace oil, costing these days Rs 16.50 per unit compared to Rs 1.02 per unit that would be the cost of power, generated from Kalabagh Dam) could be implemented for obvious reasons. Pakistan's worst enemies could not have wished a worse scenario for Pakistan. And this has happened because of the so called pursuit of "acceptable alternatives to Kalabagh Dam". This constitutes the most grievous betrayal of Pakistan and its people by its political governing class and rulers.

I don't think that a special study so comprehensively prepared, by a galaxy of professionals of many disciplines could have been so unbecomingly treated by one who made a request for it. The consequential sufferance, has befallen the people, the common men and women of Pakistan. Electric power (12 billion units from Kalabagh alone) has been denied to us that currently would have the generation cost of PKR 1.02 per unit; and in its place we have to generate electric power from Furnace Oil with a generation cost of PKR 12.04 per unit, that is (PKR 12.04 – PKR 1.02 =) PKR 11.02 per unit more or (12 billion units x PKR 11.02 per unit =) PKR 132.24 billion more every year, equal to US $ 1.50 billion equivalent to the much begged for Kerry-Lugar yearly assistance. This generosity in incurring such avoidable and wasteful expenditure is occasioned because its price is inflicted on the people of Pakistan and not its rulers and leaders, as our governance structure is so framed that the decision makers are totally protected from paying price of wrong decisions.

People normally ask what has gone wrong. If this simple question is to be answered in a sentence, it would be that the Plan recommended in the World Bank's Report of 1967 was not implemented. Government of Pakistan accepted it, WAPDA pursued it to the extent of its mandate, i.e. Projects preparation, but implementation of the first tier of the macro-plan i.e. Kalabagh Dam was thwarted. And Bhasha Dam was started much later. As WAPDA's General Manager / Project Director Kalabagh Dam, rising to become Member Water WAPDA, and later its Chairman, twice, I forcefully pursued the case. There was no position of importance that we did not meet – the President, Prime Minister, Federal Cabinet, Standing Committees of the National Assembly and the Senate, and all the Provincial Chief Ministers and Cabinets. Our standard presentation in all such contacts was very simple. Water was life, and in all matters pertaining to it, **we had to be guided by ground realities and NOT by petty prejudices, unfounded apprehensions, and vested interests.** Water was too important to play politics with especially when on the long-term basis, it was a scarce commodity.

Occasionally when I think of all such efforts, I find it unbelievable that the interest of people of Pakistan wears so thin for the "governors" of Pakistan that it could be disregarded with such ease.

Does this attitude arise out of some technical, economic / financial or social deficiencies in Kalabagh Dam Project or only for some other reasons; some stated and some unstated. The limit on the size of this article forbids me from a very detailed articulation of the professional issues. But it is sufficient to say that from 1963-67 to 1981-88, internationally reputed professionals in dams engineering, Hydrology, engineering geology, economics, finances and power engineering have been associated with Kalabagh Dam Project for site Investigations, studies and designs. The last engineering consultancy consortium was selected from a world-wide competition with full assistance and guidance of the World Bank and included top rated consulting firms from USA, UK and Pakistan. Nothing better could be possible then or even now. It can be truly claimed, therefore, that whatever is being said about the professional dimensions of KDP are not words of Shams ul Mulk or WAPDA, but of the best in the world who have confirmed that KDP was technically and financially feasible and the best option for Pakistan among ALL the choices that it had. There are reasons for these conclusions. One of that reason is that unlike Mangla and Tarbela, about 70% of KDP storage is NON-SILTABLE and would always remain so. And this would be an unmatchable advantage for a reservoir tasked to act as an irrigation facility.

Let us look at the benefits stream of KDP, in the context of strategic objectives of Pakistan's development needs.

Firstly: Agriculture and Flood protection: It would store 6.1 million acre feet (MAF) of water during the summer months, shaving off the floods peaks and releasing it during low-water months, thereby increasing the availability of rivers water for use of the provinces as well as lowering flood peaks and providing floods relief.

Secondly: Energy: It would generate 4,200 MW (about 12 billion units annually) of electricity at low cost for national needs. Based on the experience of three major hydel power stations – Tarbela, Mangla and Ghazi-Barotha – its current cost of power generation would be PKR 1.02 per unit. Compare it to Furnace Oil generated power houses, that replace the energy expected from KBD, and the oil generated power has a generation cost of PKR 12.04 per unit. Electricity from KDP would literally look like free compared to what we have.

It is thus confirmed that KDP satisfactorily fulfills the national demands in water, energy and flood protection.

Are these benefit streams distributed among the four provinces wrongfully? It does not appear to be so, because a federal agency, Indus River System Authority (IRSA) has the responsibility to distribute the available water in accordance with the Water Apportionment Accord 1991. In about 20 years of the life of IRSA, no complaint has been made by any province against a decision of IRSA to the Council of Common Interests (CCI), which is the constitutional procedure in the event of a Province seeking relief against a decision of IRSA that a Province is not satisfied with. However, this complaint is repeated in every meeting; obviously for want of any real issue of dissatisfaction.

If that is so, then why has our political governance structure surrendered to an invisible adversary, the answer could only come from them. But an outsider could only presume that the forces of vested interests were so powerful that the interests of Pakistan and its people mattered very little.

Since the real reasons for opposition to KDP appear to be unstatable, it was necessary that for public consumption some reasons are manufactured. The "leadership" of the then NWFP and Sindh Provinces willingly lent their names for "unstatable" reasons to the campaign against KDP, and a list of reasons were propagated as posing "serious dangers" to their provinces. As pointed out this was most grievous betrayal of Pakistan and its people, through a conspiracy founded on falsehoods and fabrications from start to the end. Let us examine the more serious ones among the alleged dangers.

Sindh province most often stated objection is the alleged reduction in water availability for Sindh, allegedly converting the province into a desert. In terms of water availability from the Indus rivers for irrigation purposes, KDP is no different than Mangla and Tarbela dams; KDP would in fact increase what the other two have done. Let us see what the other two – Mangla and Tarbela dams – have done. Before the construction of these mega projects, Sindh Province was receiving on an average about 36 million acre feet of water (MAF) per year. After Mangla and Tarbela the yearly average withdrawal from Indus river has increased to 43 MAF i.e. 7 MAF more. KDP would increase it by another 2.00 MAF approximately. Would this lead to desertification or better irrigation? The data of water diversion to Sindh is not of WAPDA or any other agency; it is based on the information provided by Sindh Irrigation Department and compiled by IRSA. One wonders that how could an objection so inconsistent with facts give credence and strength to a political view that KDP is harmful to the Sindh Province. The only answer could be the common saying that lies, if repeated extensively and forcefully do become a view shared by many in the absence of wide-spread knowledge about the issue. Now we come to Khyber Pukhtunkhwa (KP) Province.

The KDP opponents in KP Province state two major and serious damages allegedly posed by KDP; the flooding of Nowshera Town and water-logging of Swabi Plains. Nowshera is undoubtedly vulnerable to flooding by Kabul River which flows in the middle of the town, separating the Cantonment from the old town. It is the river Kabul which floods Nowshera. But it is alleged that KDP would obstruct Kabul River's flows, and thereby flood the town. A simple fact is that Nowshera has been flooded severely by floods of August 1929 when there was no KDP. That is why I argued with the opponents that the real reasons for Nowshera's woes are the floods of Swat and Kabul rivers. The situation is made more severe by the partial blocking of Kabul river when it meets Indus river in high floods at Khairabad. While crossing

Indus river at Khairabad towards Nowshera, if one looks to the right, one sees Indus river about 4 to 5 km wide. Immediately, if one looks to the left, one sees a narrow passage between hills on both sides through which the Indus flows. A little more downstream there is a narrower passage – the Indus gorge which is about 800 feet wide. Imagine Indus in high floods, five KM wide raging flow, disgorging through the 800 feet width of Indus Gorge that becomes the neck of the bottle which does the blocking and not Kalabagh Dam which is about 120 km further down. That is why Nowshera town was flooded in 1929, when there was no Kalabagh Dam. This prognosis was reaffirmed by the floods of July – August 2010 – a flood larger than the one of August 1929 – that had a flood level at Nowshera of 961 SPD compared to 951 SPD of 1929. The two superfloods have confirmed the irrelevance of KDP to the flooding of Nowshera town.

The objection on the so called water-logging of Swabi plains is no less preposterous. The maximum reservoir level of KDP is 915 feet SPD and it stays at that level only for a month or two, and then goes down by 90 feet to its minimum level. No place of Swabi plain is below such levels. How can Kalabagh reservoir create water logging in Swabi plains on a land that is above it, because water does not travel upwards but downwards.

A helpful simile is Tarbela Dam which is located in the vicinity of Swabi plains. The water in this reservoir are about 350 feet above the Swabi plains. If fears of the opponents are real, then these plains should have been converted into lakes. This has not happened due to the tightness of the reservoir rim and type of soil in the area which is a befitting answer to the opponents.

A detailed exposition of the alleged fears of KDP opponents would have further revealed the irrationality of their fears and their total immunity to the interest of the provinces and its people. Indus basin is known to be vulnerable to major floods. In the 65 years of its life, Pakistan has faced 12 major floods, i.e. one major flood in every five and a half years. It is the rural population, mostly poor, who face the danger and suffer the damages of floods. Because of the insignificance of the poor rural in the electoral politics of Pakistan NO ONE among the opponents have raised the issue of protection to such people.

It is not only that KDP is free from the alleged negatives, but there are some factors that make the construction of KDP essential. I would begin with the importance of KDP for KP Province.

For three provinces of Pakistan, alternatives for KBD exist. For KP Province, there is no alternative of Kalabagh Dam; and this disparity is due to the location of the irrigable area where each province shall or can use its share of water for irrigation. The irrigable areas of the three provinces of Punjab, Sindh and Baluchistan are in the plains and thus easily commanded through gravity flow in the canals which receive their supplies from the various Barrages. In case of KP Province, the land available and suitable for agriculture is about 0.8 million acres located in Bannu and D.I. Khan Districts. This land is in the form of plateaus at about 50 feet to 150 feet above the Indus River, as it flows along the eastern boundaries of these districts. This would become relevant when another dam – Bhasha Dam or dam are built and its stored water is distributed between the four provinces. While three provinces Punjab, Sindh and Balochistan would have no problem in receiving its share, the share of KP would need to be raised by 50 to 150 feet to commend the irrigable area. There are two ways to raise the Indus waters to those heights. One is to pump it i.e. lift irrigation. The other is to build Kalabagh Dam, creating a reservoir that would raise water to a height easily commanding the plateaus and thus irrigate these lands by gravity. In this way, all the provinces would have the same equitable access to their share of water. There is enormous difference in cost of irrigation between the two methods. Because of scarcity and higher electricity price, the cost for lift irrigation would be PKR 5000 per acre per year. For the gravity irrigation, it is a mere PKR 400 to PKR 500 per year per acre. Such an inequity between the provinces is most dangerous for the Federation. Even if by a miracle (miracles no longer take place) Pakistan's energy situation is converted into surpluses, the cost makes the scales irrevocably in favor of Gravity Irrigation that would be possible only by construction of KDP including the High Level Right Bank Canal. As far as KP Province is concerned, therefore, there is no replacement of KDP. To write-off KDP means in effect

writing off KP Province as a partner in benefits of development of Indus River. The slogan that Federation is more important than Kalabagh is a factual fabrication and falsehood. The correct slogan is that Kalabagh Dam is important for the federation, for national development and for all the people of all the provinces.

It has been shown that Pakistan is paying an annual price of PKR 132 billion a year for not building Kalabagh Dam. This price is not paid by angels, but by people of various provinces as below:

Punjab	PKR	68	billion per year
Sindh	PKR	40	billion per year
KP	PKR	18	billion per year
Balochistan	PKR	6	billion per year

And we have been paying a price for almost 17 years, paying for the price of building KDP, but with no benefit. My own province KP bears the Additional burden of loss of agriculture produce from 0.8 million acres. The question that is very relevant to ask Sindh and KP is while they are paying billions of Rupees annually, what is the benefit that they receive by this payment. Is there a benefit of ONE RUPEE?

Even now KDP is the cheapest hydel project and one that could be completed in a much shorter period like 6 to 7 years compared to Bhasha of 12 to 15 years. It is in the centre of power market and does not need long and costly power transmission system. If started now, it could add about 4000 MW in about 6 years which would be followed 7 years later by another 4000 MW from Bhasha. And this would usher in an era of reliable adequacy of power supplies in about 6 years, much earlier and the cheapest power.

Criticism could come against the proposed two reservoirs programme due to financing uncertainties. In my opinion, the critical factor in this matter is the credibility of the Government of Pakistan in the international community and the people of Pakistan. If it is credit worthy – not in context of finances, but integrity, competence and dedication to Pakistan – the international borders are no longer a barrier to movement of finances in pursuit of worthy investments.

We have seen the tell-tale signs in the past few decades of the coming climate change. It is now apprehended that it is coming quicker than previously anticipated. Prudent nations prepare themselves for possible adversities and thereby can avert crises; others face crisis on every turn. For forty years after Tarbela we did not build any large reservoir, with the result that we had weak defence against floods of July / August, 2010; and so the floods had their heyday. The 2000 persons who died, millions of homes that were destroyed, infrastructure of US $ 9 billion that was damaged, billions of dollars of destruction of agricultural crops and live stock was the result of the tragic national occupation of our rulers and leaders, with the personal, petty and the peripheral. This must change because no country can bear such damages, which some estimate US $ 30 to 40 billion. In the forty years after Tarbela, at least two major dams should have been built. Confined to Bhasha alone, it would mean only one reservoir in (40 + 15 =) 55 years. Kalabagh Dam must be added, <u>at least</u> in this half century period. This would enhance our resilience to the vagaries of climate change.

Let us not be impressed by the slogan that the people of KP Province or Sindh are opposed to KDP. Let us examine this claim in the context of the Election 2008 results. In KP Province, the total number of registered voters is 10.66 million. The total number of votes polled by ANP, according to the figures of Election Commission of Pakistan is 0.575 million, which is 5.4% of the total. This means that 94.6% of the voters of KP Province have not voted for ANP. Can anyone refute this? I do not have ECP figures for Sindh province; therefore, I make no observations. But the ruling coalition of that Province also does not represent 51% of the total voters.

There is a lot more to say, but the length restrictions do not allow me. However, one thing must be said; KDP is the only project that could provide facility for storage of Kabul river and thus an effective flood control in the middle and southern part of Indus Basin.

I end this article, again with a verse from Faiz, addressing the people of Pakistan. It is

میرے ہمدم میرے دوست

تیرے آزار کا چارہ نہیں نشتر کے
اور یہ سفاک مسیحا میرے قبضے میں نہیں

اس جہاں کے کسی ذی روح کے قبضے میں نہیں
ہاں مگر - تیرے سوا - تیرے سوا - تیرے سوا

My Fellow man, my Friend,
There is no cure for your sickness except the lancet,
And this butcher messiah is not in my power,

Is not in the power of any breathing thing in this world,
Except – yes !except yourself, except yourself, except yourself.

PS: A SUMMARY OF THE TECHNICAL COMMITTEE REPORT OF 2003-2005 IS APPENDED.

(Dr Hon Shams ul Mulk was a member of this committee)

Appendix

GOVERNMENT OF PAKISTAN

REPORT
OF
TECHNICAL COMMITTEE
ON WATER RESOURCES

including report of seven members of the Committee with comments of the Chairman

PART-II

Examination of TORs, Conclusions and Recommendations

AUGUST 2005

Encl: Summary page

Table

Figures in MAF

Sr. No.	Description	Water availability worked out by			
		WAPDA	Seven Members	Sardar Ahmad Mughal	Chairman TCWR (WAPDA's figures except S.No. 2.3)
1	2		4	5	6
1.	Post-Tarbela (1976-77 to 2002-2003) Escapage below Kotri	35.20	35.20	35.20	35.20
2.	Possible reductions				
2.1	Indian uses on Western Rivers	2.00	2.00	4.8	2.00
2.2	Possible uses on Kabul River by Afghanistan	0.50	0.50	4.0	0.50
2.3	Kotri outflow to sea	5.80	-	10.0	10.00
2.4	Requirements of Projects under construction				
	a. Flood Canals (Kachhi, Rainee, Greater Thal)	4.8		4.8	4.8
	b. Mangla Raising	2.9		2.9	2.9
	c. Pat Feeder Extension	0.1		0.1	0.1
	d. LBOD	2.2 *		2.2	2.2
	e. Gomal Zam Dam	1.0 *		1.0	1.0
	Sub-Total	11.00	-	11.0	11.00
2.5	Shortfall in Accord allocations	11.95	-	12.0	11.95
2.6	Future Urban and Industrial uses	-	-	5.0	-
3.	Total reductions (Items 2.1 to 2.6)	31.25	2.50	46.8	35.45
4.	Net available for further development (1-3)	3.95	32.70	(-)11.60	(-) 0.25

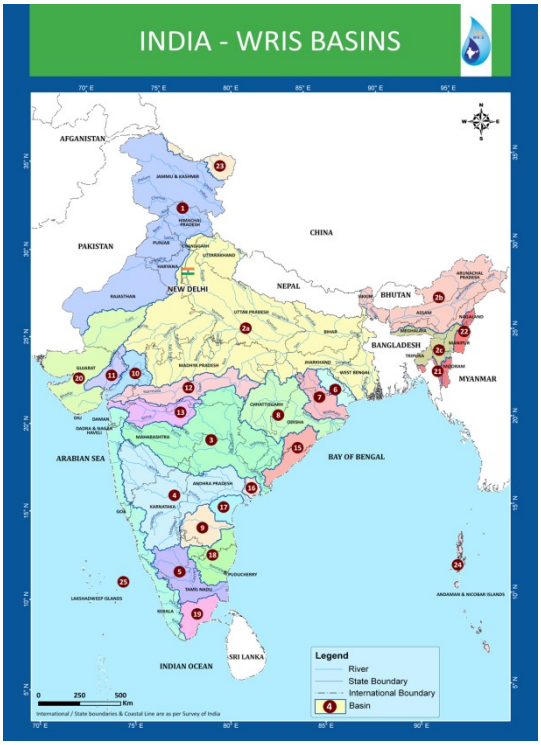
* Projects omitted by WAPDA included as decided by TCWR.

Note: No deductions made due to Eastern Rivers contribution.

Appendix: River Basins of India. Classification underIndia WRIS Basin.

Using the SRTM DEM data of NASA, having a spatial resolution of 90 meters, the basin and sub-basin boundaries for the Indian subcontinent have been delineated. As per this information, the country has been divided into 25 Major River Basins and 103 sub-basins. Names of basins are given in the table:

Sr. #	Basin Code	Basin Name	Area(sq.km)
1	1	Indus (Up to border) Basin	453931.87
2	2a	Ganga Basin	808334.44
3	2b	Brahmaputra Basin	186421.6
4	2c	Barak and others Basin	45622.41
5	3	Godavari Basin	302063.93
6	4	Krishna Basin	254743.31
7	5	Cauvery Basin	85624.44
8	6	Subarnarekha Basin	25792.16
9	7	Brahmani and Baitarni Basin	51893.68
10	8	Mahanadi Basin	139659.15
11	9	Pennar Basin	54243.43
12	10	Mahi Basin	38336.8
13	11	Sabarmati Basin	30678.59
14	12	Narmada Basin	92670.51
15	13	Tapi Basin	63922.91
16	14	West flowing rivers South of Tapi Basin	111643.87
17	15	East flowing rivers between Mahanadi and Godavari Basin	46243.06
18	16	East flowing rivers between Godavari and Krishna Basin	10345.16
19	17	East flowing rivers between Krishna and Pennar Basin	23335.82
20	18	East flowing rivers between Pennar and Cauvery Basin	63646.21
21	19	East flowing rivers South of Cauvery Basin	38646.11
22	20	West flowing rivers of Kutch and Saurashtra including Luni Basin	184441.06
23	21	Minor rivers draining into Bangladesh Basin	5453.23
24	22	Minor rivers draining into Myanmar Basin	24731.08
25	23	Area of North Ladakh not draining into Indus Basin	29238.78
26	24	Drainage Area of Andaman and Nicobar Islands Basin	6918.2
27	25	Drainage Area of Lakshadweep Islands Basin	462.59
28		Island Basin	371.4



Introduction of River Basin in India:
River basin is considered as the basic hydrological unit for planning and development of water resources. There are 12 major river basins with catchment area of 20000 km^2 and above. The total catchment area of these rivers is 25.3 lakh km^2. The major river basin is the Ganga-Brahmaputra-Meghna , which is the largest with catchment area of about 11.0 lakh km^2 (more than 43% of the catchment area of all the major rivers in the country). The other major river basins with catchment area more than 1.0 lakh km^2 are Indus, Mahanadi, Godavari and Krishna. There are 46 medium river basins with catchment area between 2000 and 20000 km^2. The total catchment area of medium river basins is about 2.5 lakh km^2. All major river basins and many medium river basins are inter-state in nature which cover about 81% of the geographical area of the country.**There are five classifications.**

8. CLIMATE CHANGE & TRANS-BOUNDARY WATER STRESS. STUDY OF THE JHELUM RIVER BASIN

Begum Dr. Zaigham Habib

8.1 Introduction

The Indus Basin is shared by Pakistan (54% of the area), India (33%), Afghanistan (6%) and China (7%). The India and China have higher percentage of the mountain and glaciated areas, while Pakistan hosts 61% of the Basin population and more than 65% of the agriculture land. The Indus River system contributes 97% of Pakistan's river water resources. Pakistan faces high water stress and is gradually becoming a water insecure country on multiple fronts. The mapping of water stress by different international organizations (FAO, UNESCO, IWMI, WB) has identified four major stress factors, i) limited availability of water for further economic uses (physical and economic water stress), ii) level of existing river water uses more than 80% and about 85% of the developed water resources used in agriculture, iii) groundwater extraction more than 100% in the sweet water zone, and iv) high climate change vulnerability.

Pakistan is the 6th largest country of the world with nearby 190 million population and a low capita annual GDP. The war on terror & energy crises have pinned the growth rate to less than 4%. The most dependable sector of the economy is agriculture providing employment to about 40% population, contributing 23% to the GDP and ensuring the national food security. Because of high aridity & salinity and or brackishinaccessible groundwater aquifer across 40% of the country, dependence on surface water resources is profound &critical. Current gross per capita water availability is 1050 cubic meters per capita. Based on population, water scarcity is expected to increase more than 2% annually. While, alarming emerging factors are decrease in water resources due to climate change, increasing extreme events and uncertainties related to upstream development and unplanned/unaccounted water uses.

Before 1947, the Indus Basin was developed as a single basin with 88% of its uses in the region now a part of the Pakistan. India and Pakistan signed a treaty in 1960 after 12 years of hard negotiation, called Indus Waters Treaty (IWT). The World Bank was a key mediator in IWT negotiations with the backing of International Community. The IWT used to be mentioned as a successful treaty. While, during the last 10 years Pakistan has launched many campaigns within the Indus Commission and approached WB and International Court for third party arbitration and etc. The drinking water needs were absolutely ignored in IWT 1960.

With existing water stress, Pakistan is highly vulnerable to climate change impacts and extreme weather events. This has been manifested by the prolonged draughts of 2001-2, mega and wide spread Indus floods of 2010 and a historical pluvial flood in the Lower-Indus and coastal region in 2011. There is little understanding of climate change phenomena across and within the Indus Basin. The limited monitoring from the Himalaya and Karakorum ranges show diversities in climate parameters, water cycle, glacier behavior and external linkages. The questions remain unanswered about glacier and snow cover area, accuracy of projections, changes in summer and winter rains, decreasing river flows in two eastern rivers and groundwater aquifer behavior (ICIMOD, Romshoo, others). The water security in the Indus basin is going to be strongly linked with the management and protection of water resources – more towards water use side. The understanding of water availability and stress factor can be a catalyst to improve the water governance and the water use efficiencies.

8.2 Project Description

8.2.1 Objective

To improve existing knowledge of the trans-boundary Jhelum river basin water resources, water uses & climate trends to understand the emerging water stress & security scenarios.

8.2.2 Methodology

A modular and integrated approach has been proposed for comprehensive assessment of the water resources and climate trends in the Jhelum River catchment. The salient features of the methodology are:

1. Complete water-cycle and water-balance approach to analyze the Jhelum Basin and its selected watersheds.

2. Integrated analysis for spatially delineated Jhelum River sub-catchments.

3. Evaluation of the information published during recent years about the Indus and Jhelum Basin; including hydro-climatology variables (glacier, snow, precipitation, GW aquifer, temperature, etc), land and water use in agriculture and other sectors, soil conditions, population density, etc.

4. Primary data collection to fill in the gaps and refine macro-analysis.

5. Three steps of the analysis:

    - monitoring and assessment of water resources, water demand and uses *(need to explore the scope of using RS Evaporative Fraction and Vegetative Index techniques .....can be discussed with Wim Bastiaanssen),*

    - Identifying climate change & water resources trends and grey areas under different scenarios,

    - Water Scarcity and water stress analysis in future perspectives.

6. Tools and Models: a combination of three key mathematical modules; i) downscaled dynamic climate model, ii) a hydrological model, iii) a water resources planning model (MIKE Basin, WEAP, etc). Integrated DEM models have been discussed by the recent research, hence available. The accessibility will be an issue. *The selection of models and tools needs to be refined for the final proposal. Already used models and work done by other institutes will influence the selection.*

8.3 Study Area

8.3.1 Jhelum River

The river Jhelum originates from the spring “Cheshma Verinag”, 80 km south-east of Srinagar at the foot hills accommodating Banihal pass at an altitude of 5760 ft. Its total length is 402 km, about 165 km on the Indian side. The catchment area of Jhelum is about 17622 sq. km. The river Jhelum runs in the Valley surrounded by mountain ranges rises to a height of 5487 m on the north east. These mountainous peaks are covered by snow from the month of October to May. The valley is perched at an

average elevation of 1829 m above sea level. About 55% of the Jhelum catchment lies in Indian held Kashmir and 45% lies in AJK and Pakistan.

During winter the precipitation is caused by the western disturbances with or without the linked frontal systems. Precipitation occurs at a relatively uniform rate and is generally light except when associated with a cold front. The normal rate has been observed to be around 0.1 - 0.2 inch/hour, which may reach 0.4 - 0.6 inch/hr in extreme cases. The axis of maximum precipitation during winter lies at El.8000-10000 ft. SPD. The winter precipitation is extremely important as a source of runoff during summer. It forms about 60% of the annual precipitation over the Greater Himalayas and thus the amount of runoff caused by it during summer is more than the runoff due to the rainfall.

- River System

  Before the river enters the main city of Srinagar, Jhelum is joined by 14 tributary rivers including Lidder and a stream from Dal Lake. Below the Srinagar city, Dudh-ganga and nallah Sindh joins the river. About 20 kms downstream the river joins Wullar Lakes and takes off from the lake at its south west corner and flows to the west south west direction through the alluvial plain for a length of 21 km upto Baramulla. At Baramulla the river enters a gorge and takes off a sharp bend towards the left. The end of the gorge at Khadanyar is marked by huge rock projecting into the river from the left side.

  Major tributaries of Jhelum on the Indian side:

  Nallah Lidder is about 70 km long stream drains 580 sq.km before it joins Jhelum. It is fed by a large number of glaciers from the high ranges towards the upper Sindh Valley and flows in gorges between high mountains for the most of the distance. Nallah Sindh originates from Haramukh Mount, travels about 96 Kms and drains 1536 sq.km. As the river enters in the plains, it spreads into numerous branches forming an extensive delta. The delta is covered in its substantial portion by shallow marshes known as Anchar. Nallah Vishow originates from the foot hills of Pir Panchal range between Sidan and Banihal ranges. It is well defined channel between high banks. It traverses a total length of 60 Kms and drains about 1210 Sq. Km. Rambiara Nallah drains the high hills between Pir Panchal and Rupri Passes. The total catchment of this stream is about 270 Sq. Km. and the total length is 68 Km. Dudhganga river rises in the central part of Pir Panchal around mountains “Tala Kosi”. It is contributed by two mountain Streams “Sungsafad” and “Yachera”. The total catchment of this stream is 165.8 Sq. Km. About 55 km long Pohru nalla originates from Lolab Valley and drains a catchment of about 480 Sq. Km. On emergence from the Wular Lake near Baramula, it runs through an eighty-mile long gorge at an average slope of 33 feet per mile.

  Major tributaries of Jhelum on Pakistan side

  At Domel, near Muzaffarabad, Jhelum is joined by its largest tributary, Neelum (Kishan Ganga), which drains about 2800 square miles of hilly area lying on the eastern side of the Nanga Parbat. The Neelum drains Himalayan ranges between fifteen to twenty thousand feet high covered by snow and glaciers. Five miles below the Domel, the Kunhar tributary , joins the River Jhelum, draining nearly 1,080 square miles of the Kaghan Valley. Sources of River Kunar lie at about 15,000 to 17,000 feet above sea level. It hosts the famous Saif-ul-Molook Lake. Another tourist point of Jhelum is Lalusar Lake. From Domel to Mangla (90 miles) two streams Kanshi and Poonch join the River Jhelum. The Poonch joins Jhelum at Tangrot, about seven miles above Mangla reservoir. It drains southern sides of Pir Panjal, 10,000 -12,000 ft high range snow bound in winter. The Kanshi is mainly monsoon floodwater stream draining the Jhelum and Rawalpindi districts of Punjab.

The Mangla Dam constructed in 1967 lies in districts Mirpur and Jhelum. From Mangla down to Rasul, several floodwater streams drain into the Jhelum. The Kahan Nullah is nearly forty miles long and drains the Rohtas area, where an auxiliary storage of Mangla Dam was considered. Suketar, Jaba Kas and Bunha are three of the many floodwater nullahs that drain into the Jhelum.

8.4 IMPORTANT TRIBUTARIES AND THEIR CATCHMENT AREAS

8.4.1 Some Inferences from the Previous Research

Nature of Water Stress faced by Pakistan

Hydrological water stress of the Indus basin is represented by many indicators. The transboundary or shared aquifer is 48% stressed, need to reduced pumpage is estimated by more than 20% (Wada, Heinrich, Environ. Res. Lett. 8 2013). The Indus Basin on Pakistan's side has "blue water stress" during nine months of a year (A.Y. Hoekstra, M.M. Mekonnen Sep 2011; UNESCO Global Water Scarcity), indicating higher demand than existing water availability. Pakistan's hydro vulnerability is linked to three basic water resources characteristics. Indus is the single and shared basin with temporally skewed water resources, more than 70% of surface water (rain and river flows) enters into the country during eight summer months, groundwater aquifer in all fresh water zones is over-drafted.

8.4.2 River Flows and Glacier melt

The statistical analysis indicating decrease in the flows of Jhelum river is reported by many research studies in Pakistan (Yaseen. M 2013, --, Study III Environmental Concerns of All Provinces 2005). However, there are two limitation of this type of analysis. The annual and seasonal river flows are highly variables and one extreme event (flood or draught) can influence the statistical trends. This type of analysis does not consider hydrograph and the causes of decrease in flows, hence not quantify the contributing factors. A decrease in Glacier and snow cover area is reported many recent studies (Romshoo 2013, NARC 2012, SUPARCO 2013, ICIMOD). Which need to be integrated in a water-cycle.

8.4.3 About the Climate Change modeling

Conclusions from a review by A. J. Lamadrid and K. L. MacClune summarize methodological gaps in the existing CC research (Climate and Hydrological Modeling in the Hindu-Kush Himalaya Region 2010).

- Based on the review of hydrological models and the identified gaps, recommendations for feasibility of an impact assessment are:
- First and foremost, for a hydrological impact assessment, the future of ice and snow in HKH needs to be elucidated with robust results. Steps in this direction include:
- Coupling of glacier, climate and hydrological models to assess the impacts of climate change on glaciated areas and downstream flows (i.e. dynamical glacier schemes (DGS) & hydro-glaciological models);
- Inclusion of glacier parameters into hydrological models, including substitute simple transfer functions with dynamical glacier representation. A recent regional glacier ablation gradient model (Armstrong et al., 2009, Alford et al., 2009) and models for estimating snow- and ice-melt contributions to streamflow such as SNOWMOD (Singh and Jain, 2003) and SRM (as

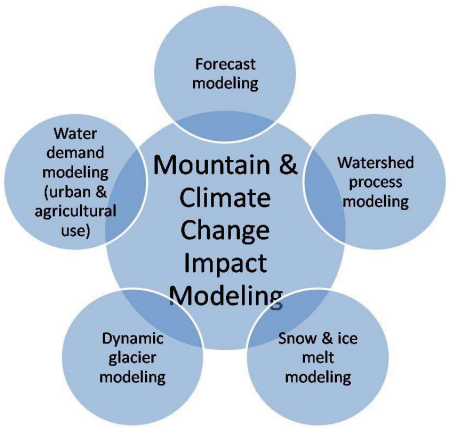
used by Immerzeel et al., 2009) can be used in catchment models to work toward solving cryosphere impacts in the HKH under climate change.

- Driving watershed models with downscaled climatic model output to measure hydrological response to projected climatic change. Ideally the climate model output should include local effects such as rainshadows and orographic precipitation. Models such as JULES provide a way forward for modeling incorporating climate model output into land surface modeling. It should be noted though that hydrological models have their own set of uncertainties resulting from their own assumptions about the physical processes that they simulate. Combining the limitations of climate and hydrological models compounds uncertainty, demanding both modelers and model interpreters to be very clear about the assumptions made and the implications of model output.

- Further developments and testing of models of all phases of the hydrological cycle in the HKH should be continued, and two-way climate-hydrological coupling should also be pursued through inter-institutional and international cooperation.

8.4.4 Integrating the Processes affected by the Climate Change

The famous and widely reported diagram below identify five key processes to be modeled as a part of climate change impact modeling .Very limited and gross studies using low resolution Global Climate models have been carried out in the Indus Basin (esp. on the Pakistan side).



8.5 Research Issues in the Context of existing projections and transboundary concerns

1. For a consistent development approach on both sides and future transboundary cooperation, the quantification of water resources in all forms, their annual spatio-temporal behavior, existing and expected future trends of water availability and climate change impact must be monitored, measured and analyzed with increasing accuracy. The research and investigation in shared catchments has the biggest potential and future scope.

2. The Indus basin and its various watersheds (Jhelum, Chenab, Indus, Ravi and others) needs to be accurately mapped for water-security challenges. It includes; i) estimation of water stress factors, ii) water bodies quantity and quality, iii) sensitive areas of transboundary water stress in the context of planned development of water resources, iv) key climate change trends, v) areas of future transboundary cooperation.

3. As shown above, behavior of Glaciers and Snow cover areas needs urgent, intense and well coordinated physical monitoring and assessment using downscaled and more relevant models. The climate change impact projections of the last 10 years indicate the need to carry out small scale (meso-level) detailed watershed studies including hydrological and climate change variables.

4. The groundwater levels in all shared aquifers have become important because of over-drafting of groundwater aquifer, deterioration of aquifer water quality and growing drinking water

concerns on both sides of the boarder. The Indus Water Treaty (IWT) does not talk about the shared aquifers. While, all fresh water shared aquifers are largely connected, highly dynamic, recharged following an annual water cycle, and consistently mined by the private and public sectors. The sustainable potential of aquifers needs to be quantified, along with their recharge and water quality characteristics.

5. Existing water uses in the basin face two dimensional risks; i) increased multi-sector competition across the livelihood and economic sectors because of higher water demand in each sector, ii) higher uncertainty in water availability – enhanced by the climate change projections. The water use efficiency measures advocated and tried are not producing required results. The research and practical experiences are available in both countries at various levels. The missing links are comprehensive and spatially defined studies for various sub-catchments of the Indus Basin indicating existing demands, water availability, supply, impacts of development and future sustainability scenarios.

6. During the last ten years large number of global studies has proposed various water stress and water security indicators. However, generally one value is produced for the whole Indus-basin, which in reality varies many folds within the basin. Secondly, data used for the calculations are not consistent in scale, timing and sometimes even in variable-definition. Two types of application leading to the re-estimation of water-stress and water security indicators can greatly contribute towards better dialogue.

    a. The spatio-temporal delineation of water stress indicators calculated at the su-base or watershed level.

    b. Developing water security indicators for the Indus Basin

7. Improvement the climatic and hydrological models have been recommended by all studies carried out in the Basin, especially on Pakistan side.

8.6 Research Components

A comprehensive water cycle study of the Jhelum Basin (already a sub-basin of Indus) is the best option in a transboundary context. The physical boundaries for the water inflow, outflow and uses can be clearly defined. Such a study can focus on the key challenges faced by the basin in a more deterministic way, without missing the essential linkages. It will also allow to analyze technical, economic and performance issues with minimum transboundary political constraints. The basin level gross analysis can be followed by the few lower levels studies to explore some specific issues.

A. Spatial delineation of the Jhelum River catchment considering watershed and topographic characteristics

- A simple Digital Elevation Model (DEM) for the whole Jhelum catchment
- Detail digital mapping of the watersheds of interest

B. Coupled climate and hydrological modeling of the selected sub-catchments, to assess the impacts of climate induced hydrological changes

- Critical review of the existing climate change reports and studies;

- As referred in the section 2.5.2, study of hydrological impacts of climate change using a downscaled hydro-glaciological model.

- To understand some unexpected trends, the forecast scenarios can be started from a back date.

- A comparison of projected and actual changes

- Interaction with component 4.2

C. Complete water-cycle analysis of the selected sub-catchments; including land use, groundwater aquifer, water demands, water uses, systems efficiency in the major sectors and a complete water balance

- Monitoring, field data collection and simulation of various water cycle components, like;

  i. Total water availability from snow glacier melt, rainfall and recycled water using actual data as well as probabilistic scenarios representing, i) post 1960 occurrence frequency, ii) climate change projections

  ii. Water uses in different sectors – FAO has been working with SUPARCO Pakistan after the floods of 2010 for satellite based Agromet data. The technology is still in the process of improvement, however, it provides useful information for a comparison and to understand the gaps.

  iii. Groundwater recharge, abstraction and flow patterns. A lot of information are available, which can be used to calibrate a 3-D model. Because of steep slopes in the transboundary region, sub-surface flow directions are easy to monitor. New monitoring techniques can be tested and methodologically developed for a large area monitoring.

  iv. An integrated basin level model (like MIKE basin) to simulate and assimilate above mentioned data. The model can compare different demand-supply scenarios, climate change impacts, future development options, etc.

D. Water scarcity and water security indicators – existing and future Scenarios

- Water scarcity indicators to represent the present and projected scenarios in various sectors, water bodies and environmental concerns based on above analysis

- Water Scarcity analysis

E. NASA-GRACE assessment as appended shows more than 10bcm annual water mining adjacent to Punjab Pakistan and a reverse aquifer slope ie; GW flowing from west to east – I think NASA issued another report in 2014 after strong criticism from recharge potential in Indus Basin India. The appendix gives the detailed assessment.

8.7 Timeframe and Institutional Arrangements

The study is planned within three years.

8.8 References

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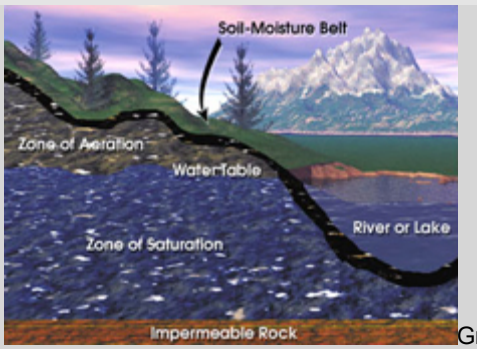
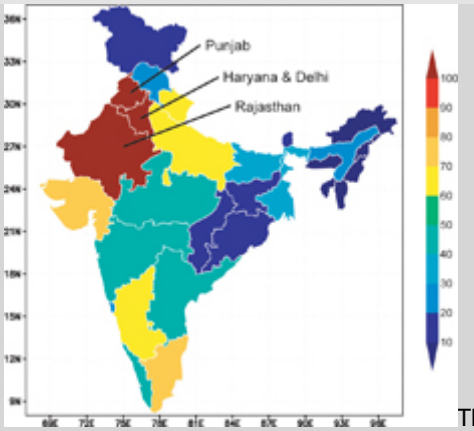
Appendix-I

NASA Satellites Unlock Secret to Northern India's Vanishing Water
08.12.09

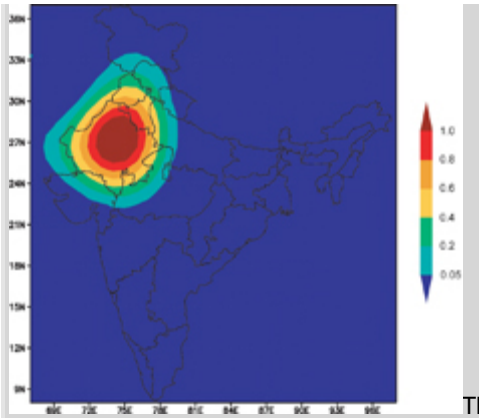
NASA Hydrologist Matt Rodell discusses vanishing groundwater in India. **Credit:** NASA
› Watch Video



Groundwater resides beneath the soil surface in permeable rock, clay and sand as illustrated in this conceptual image. Many aquifers extend hundreds of feet underground and in some instances have filled with water over the course of thousands of years. **Credit:** NASA
› Larger image



The map, showing groundwater withdrawals as a percentage of groundwater recharge, is based on state-level estimates of annual withdrawals and recharge reported by India's Ministry of Water Resources. The three states included in this study are labeled. **Credit:** NASA/Matt Rodell
› Larger image



The averaging function (spatial weighting) used to estimate terrestrial water storage changes from GRACE data is mapped. Warmer colors indicate greater sensitivity to terrestrial water storage changes. **Credit:** NASA/Matt Rodell

› Larger imageBeneath northern India's irrigated fields of wheat, rice, and barley ... beneath its densely populated cities of Jaiphur and New Delhi, the groundwater has been disappearing. Halfway around the world, hydrologists, including Matt Rodell of NASA, have been hunting for it.

Where is northern India's underground water supply going? According to Rodell and colleagues, it is being pumped and consumed by human activities -- principally to irrigate cropland -- faster than the aquifers can be replenished by natural processes. They based their conclusions -- published in the August 20 issue of Nature -- on observations from NASA's Gravity Recovery and Climate Experiment (GRACE).

"If measures are not taken to ensure sustainable groundwater usage, consequences for the 114 million residents of the region may include a collapse of agricultural output and severe shortages of potable water," said Rodell, who is based at NASA's Goddard Space Flight Center in Greenbelt, Md.

Groundwater comes from the natural percolation of precipitation and other surface waters down through Earth's soil and rock, accumulating in aquifers -- cavities and layers of porous rock, gravel, sand, or clay. In some of these subterranean reservoirs, the water may be thousands to millions of years old; in others, water levels decline and rise again naturally each year.

Groundwater levels do not respond to changes in weather as rapidly as lakes, streams, and rivers do. So when groundwater is pumped for irrigation or other uses, recharge to the original levels can take months or years.

Changes in underground water masses affect gravity enough to provide a signal, such that changes in gravity can be translated into a measurement of an equivalent change in water.

"Water below the surface can hide from the naked eye, but not from GRACE," said Rodell. The twin satellites of GRACE can sense tiny changes in Earth's gravity field and associated mass distribution, including water masses stored above or below Earth's surface. As the satellites orbit 300 miles above Earth's surface, their positions change -- relative to each other -- in response to variations in the pull of gravity. The satellites fly roughly 137 miles apart, and microwave ranging systems measure every microscopic change in the distance between the two.

With previous research in the United States having proven the accuracy of GRACE in detecting groundwater, Rodell and colleagues Isabella Velicogna, of NASA's Jet Propulsion Laboratory and the University of California-Irvine, and James Famiglietti, of UC-Irvine, were looking for a region where they could apply the new technique.

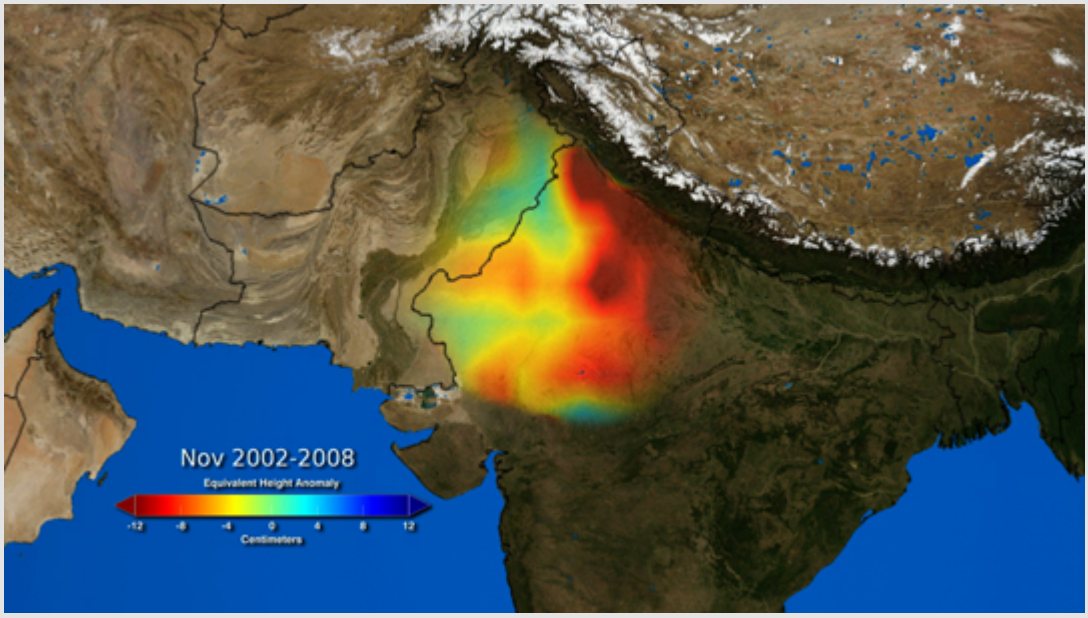
"Using GRACE satellite observations, we can observe and monitor water changes in critical areas of the world, from one month to the next, without leaving our desks," said Velicogna. "These satellites provide a window to underground water storage changes."

The northern Indian states of Rajasthan, Punjab and Haryana have all of the ingredients for groundwater depletion: staggering population growth, rapid economic development and water-hungry farms, which account for about 95 percent of groundwater use in the region.

Data provided by India's Ministry of Water Resources suggested groundwater use was exceeding natural replenishment, but the regional rate of depletion was unknown. Rodell and colleagues had their case study. The team analyzed six years of monthly GRACE gravity data for northern India to produce a time series of water storage changes beneath the region's land surface.

They found that groundwater levels have been declining by an average of one meter every three years (one foot per year). More than 109 cubic km (26 cubic miles) of groundwater disappeared between 2002 and 2008 -- double the capacity of India's largest surface water reservoir, the Upper Wainganga, and triple that of Lake Mead, the largest man-made reservoir in the United States."We don't know the absolute volume of water in the Northern Indian aquifers, but GRACE provides strong evidence that current rates of water extraction are not sustainable," said Rodell. "The region has become dependent on irrigation to maximize agricultural productivity, so we could be looking at more than a water crisis."

The loss is particularly alarming because it occurred when there were no unusual trends in rainfall. In fact, rainfall was slightly above normal for the period.



As animated here, groundwater storage varied in northwestern India between 2002 and 2008, relative to the mean for the period. These deviations from the mean are expressed as the height of an equivalent layer of water, ranging from -12 cm (deep red) to 12 cm (dark blue). Credit: NASA/Trent Schindler and Matt Rodell
› Download animation (9 Mb mp4)

The researchers examined data and models of soil moisture, lake and reservoir storage, vegetation and glaciers in the nearby Himalayas, in order to confirm that the apparent groundwater trend was real. Nothing unusual showed up in the natural environment.

The only influence they couldn't rule out was human.

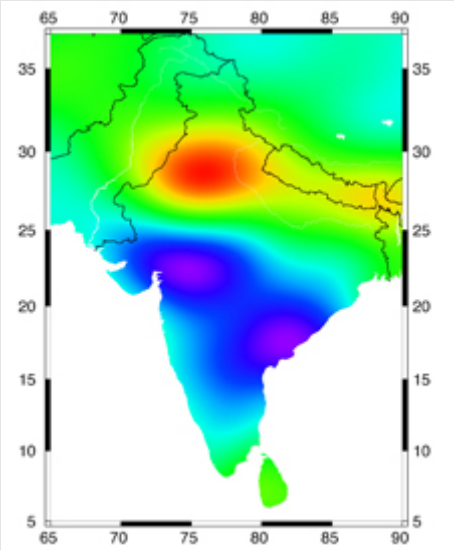
"At its core, this dilemma is an age-old cycle of human need and activity -- particularly the need for irrigation to produce food," said Bridget Scanlon, a hydrologist at the Jackson School of Geosciences at the University of Texas in Austin. "That cycle is now overwhelming fresh water reserves all over the world. Even one region's water problem has implications beyond its borders."

"For the first time, we can observe water use on land with no additional ground-based data collection," Famiglietti said. "This is critical because in many developing countries, where hydrological data are both sparse and hard to access, space-based methods provide perhaps the only opportunity to assess changes in fresh water availability across large regions."

Related Links:

› India's Water Economy: Bracing for a Turbulent Future (pdf, 2005)
› GRACE mission page at JPL
› GRACE mission page at University of Texas
› Who is Matt Rodell?
› Who is James Famiglietti?
› Who is Isabella Velicogna?
› Getting at Groundwater with Gravity
› Earth's Weighty Wellsprings
› The Water Cycle

Related Image



The map shows groundwater changes in India during 2002-08, with losses in red and gains in blue, based on GRACE satellite observations. The estimated rate of depletion of groundwater in northwestern India is 4.0 centimeters of water per year, equivalent to a water table decline of 33 centimeters per year. Increases in groundwater in southern India are due to recent above-average rainfall, whereas rain in northwestern India was close to normal during the study period. **Credit:** I. Velicogna/UC Irvine
› Larger image

Gretchen Cook-Anderson
NASA Earth Science News Team

Appendix-II

WATER RESOURCES OF PAKISTAN

The Indus River and its tributaries have uniquely vast catchments, spreading from the high north-western mountains of 8500 meters to the low level Pothwar Plateau of 300 meters elevation. The 400,131 square km Himalayan watershed of Indus and its tributaries includes world's largest glaciers outside the polar region. These are the great natural storage reservoirs of snow that feed and regulate the river Indus and its tributaries. The Western Himalayas, Hindukush and Karakorum mountainous regions are shared by China, India, Afghanistan and Pakistan. The gross drainage and service area of the Indus and its tributaries exceeds 1.1 million square kilometers .

Starting from the Tibetan plateau, drainage ranges of numerous small and large tributaries feed three large river systems; Indus, Ganges and Brahmaputra. Across their path, dozens of trajectories host natural lakes, provide ecological services, support rangelands and livelihood while passing through hundreds of hilly hamlets. In the mountainous catchments, lower Himalayan and Siwalik ranges extend over 65,000 square km of sedimentary rock and gravel formations. A part of monsoon rains percolates and is stored in the porous formation and is released later through springs or natural reservoir that feeds the rivers. The snow melt and rainfall contributes respectively 65% and 35% to the Indus rivers flows. Catchments areas and inflows of the main rivers are given in Table 1.

TABLE **1**: AREAS, FLOWS AND RAINFALL IN INDUS RIVERS CATCHMENTS[4]

River	Catchments/Basin Areas in Sq. km	River Flows Top RIM Stations Pakistan (MAF)	Precipitation/Rainfall (mm)
Indus at Tarbela	2,88,000	62.14	1400 to 125
Kabul at Nowshera	67,760	21.00	900 to 100
Jhelum at Mangla	39,200	22.75	1500 to 250
Chenab at Marala	41,760	26.53	950 to 150
Ravi, Sutlej & Beas	100,330	2	900 to 150

Note: *Flows based on WAPDA/PIDs; Catchments Area Federal Flood Commission Pakistan, Wikipedia; Rainfall by the author based on different data-sets.*

The impacts of increased human activities, environmental and climate changes are already felt in the basin but not quantified yet. The international literature associates high risk and vulnerability with surface water resources of the Indus Basin (Mool.P.K.et al, ICIMOD 2003). Some optimism exists about the future of glaciers feeding the Indus River because of Karakoram Anomaly (glacier surge) reported by researchers like Hewitt, K., 2005. However, recent trends of extreme events (draughts and floods) and large climate induced losses present a challenging situation for Pakistan.

The glaciated and snow cover areas are decreasing because of increased inhabitation, economic activities, tourism and strategic presentation of armies in the region. A retreat of Siachin glacier due to military establishments of India and Pakistan is well established now (ICIMOD 2004, Kashmir at the Brink of Climate

[4] Over 60% of the total area of the Indus basin lies in Pakistan and Pakistan-administered Kashmir. India and Occupied Kashmir has about 15%, Tibet has about 10% and the Republic of India and Afghanistan each have about 7% of the catchments. The entire basin covers about 384,000 square miles of open land, of which 204,000 lie in Pakistan. In addition, about 29,000 square miles lie outside the Indus basin but are dependent on the Indus river system for their water requirements and irrigation supplies. Almost all of the basin in Pakistan receives an overall rainfall of less than 15 inches, 60% of its area receiving less than 10 inches, while, 16% receives less than 5 inches. (**Wikipedia**)

change 2008?). In Chenab and Jhelum catchments, an alarming decrease of snow cover area and melting of smaller glaciers is reported by the Indian studies ((Arjimand Hussain Talib (ActioAid 2007). The ActionAid report names about twenty glaciers, which have reduced in size or disappeared. Hangipora glacier in Anantnag, Naaginad glacier, Galgudi and Wandernad glaciers in Chaklipora, Katha, Budrukotand Khujwan glacier Kichama area has reduced from 40ft to only 20ft. The Afarwat glacier, Nambalnar Hajibal, Shamasbari and Sadhna in Karnah region and a major Najwan Akal glacier have almost disappeared.

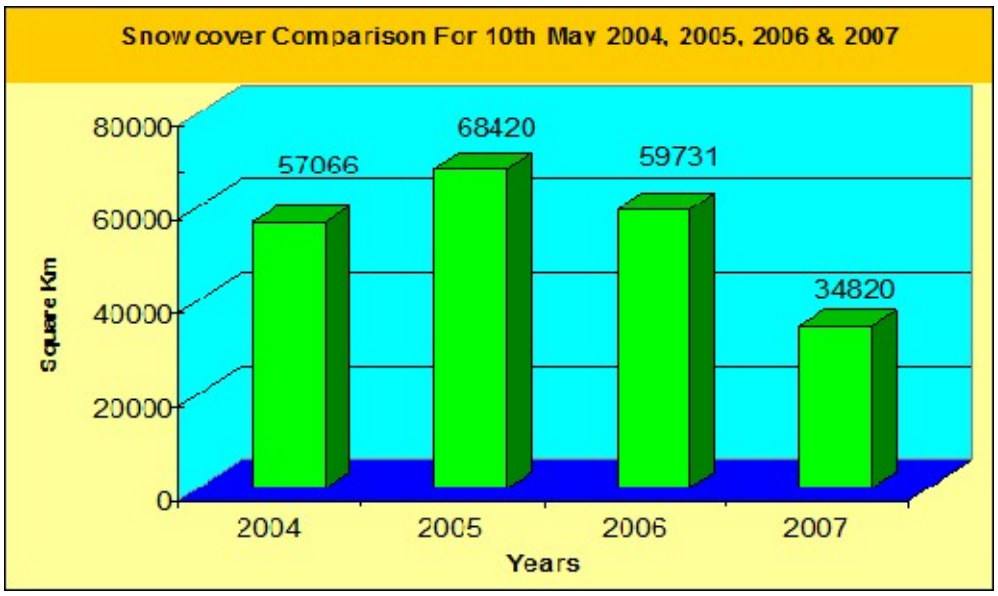


Figure 1: Variation in Snow Cover area- GCISC

Pakistan has faced unprecedented weather events and climate change impacts during the last two decades. A wet-span and flood events in 1992 and 1994-95 were followed by two years of draughts during 2000-2002 across about 40% of the basin, covering Southern Punjab Sindh. A combination of three weather systems caused super flood in 2010 displacing about seventeen million people. A unique weather-system of monsoon rains flooded the Lower Indus for months. In addition to small Glacier Outburst Lakes, a rare large lake was formed at Attabad in Gilgit-Baltistan region in 2009 due to land sliding and completely blocking a tributary river of Indus, Hunza (feeding the Gilgit river).

Rainfall Variability

On the average Pakistan experiences dry and semi-arid climate. Humid conditions prevail over a small area in the north. The whole of Sindh, most of Balochistan, the major part of the Punjab and central parts of Northern Areas receive less than 250 mm of rainfall in a year. Northern Sindh, southern Punjab, north-western Balochistan and the central parts of Northern West Areas (Khyber Pakhtunkhwa province) receive less than 125 mm of rainfall. The monsoon brought by the South-eastern winds is the major source of rainfall in summer, mostly between July and September. The western depression brings light rains to a small western range from December to March. True humid conditions appear after the rainfall increases to 750 mm in plains and 625 mm in highlands.

Figure 1 shows the average annual precipitation across the country and figure-2 a shifted counted over ten years from 1996 to 2006 (MET Dept. Pakistan). The average rainfall is less than 250 mm across 70% of the basin and higher than 700 mm only in a small northern zone. The average annual variations during the ten years were within 20%. However, year to year variation can be high in the monsoon region. The rainfall has become more erratic across the South Asia during the last few years, with marked regional differences. The rainfall and cyclones in coastal areas have increased due to sea temperature rise. The frequency of extreme events is substantially enhanced in the coastal areas.

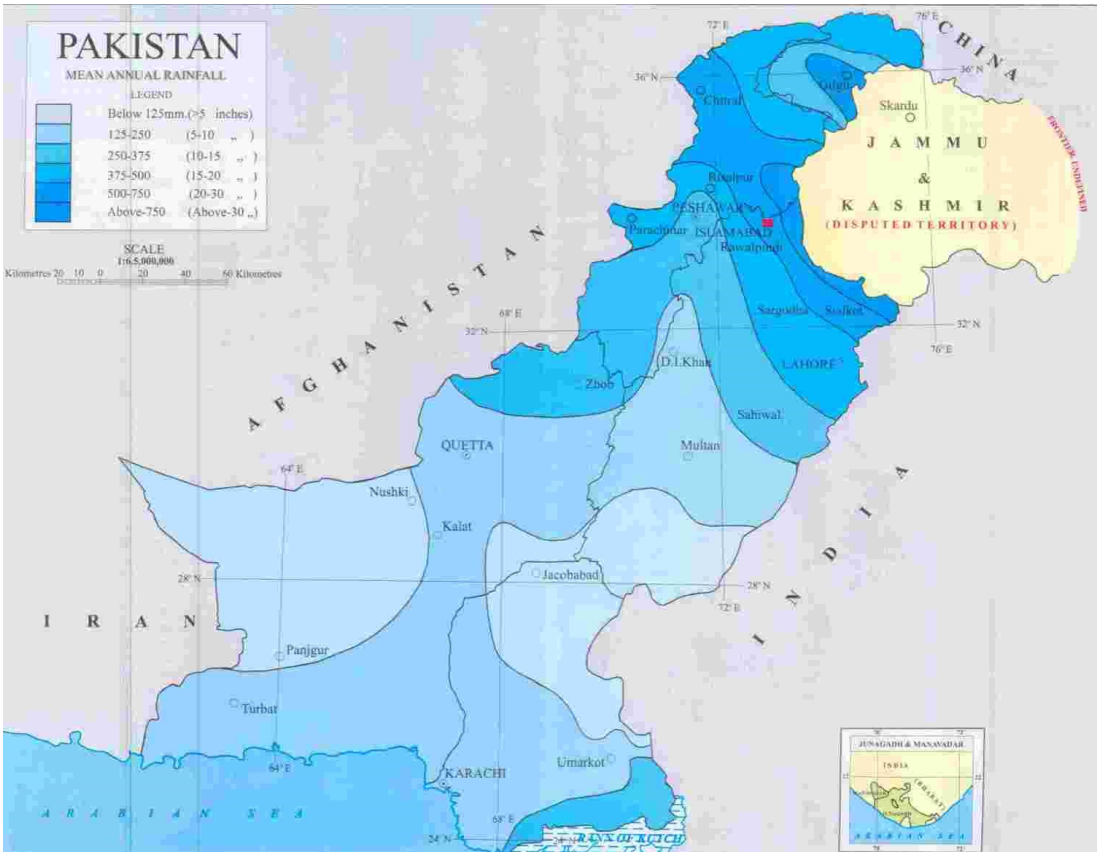
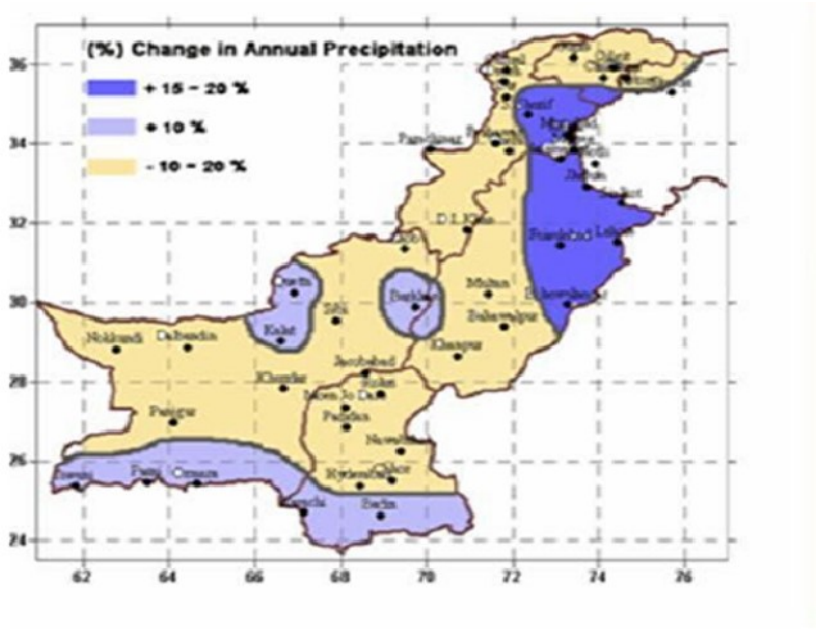


Figure 2: Average Annual rainfall Pakistan



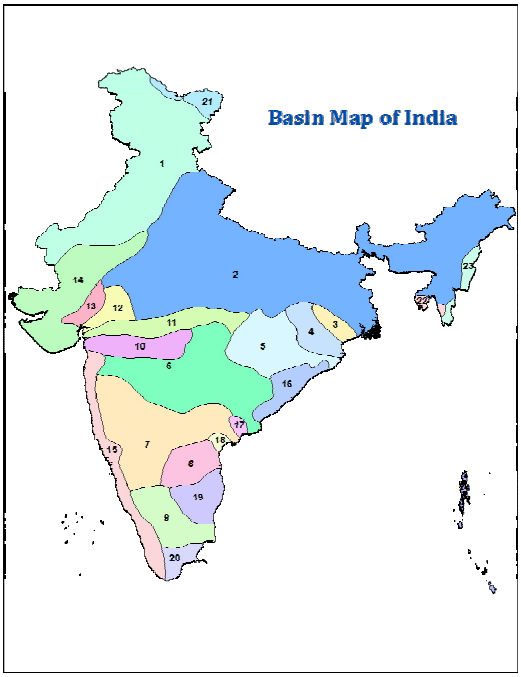
%Age change in precipitation variation in Pakistan
Source: Pakistan Meteorological Department, Islamabad

Figure 3: Precipitation Variation 1996 to 2006

Appendix: River Basins of India. Classification under NCIWRDP Basin.

The entire country has been divided into 24 basins as per **National Commission for Integrated Water Resources Development Plan (India)**. The names of the basins and area are given in the table.

Sr. #	Basin Code	Basin Name	Area(sq.km)
1	1	Indus	321289
2	2	Ganga-Brahmaputra-Meghna	1101242
3	3	Subarnarekha	29196
4	4	Brahmani-Baitarani	51822
5	5	Mahanadi	141589
6	6	Godavari	312812
7	7	Krishna	258948
8	8	Pennar	55213
9	9	Cauvery	87900
10	10	Tapi	65145
11	11	Narmada	98796
12	12	Mahi	34842
13	13	Sabarmati	21674
14	14	West Flowing Rivers of Kutch and Saurashtra Including Luni	334390
15	15	West Flowing Rivers South of Tapi	113057
16	16	East Flowing Rivers between Mahanadi and Godavari	49570
17	17	East Flowing Rivers between Godavari and Krishna	12289
18	18	East Flowing Rivers between Krishna and Pennar	24649
19	19	East Flowing Rivers between Pennar and Cauvery	64751
20	20	East Flowing Rivers South of Cauvery	35026
21	21	Area of North Ladakh Not draining into Indus	28478
22	22	Rivers draining into Bangladesh	10031
23	23	Rivers draining into Myanmar	26271
24	24	Drainage Area of Andaman and Nicobar and Lakshadweep	8280



Introduction of River Basin in India:
River basin is considered as the basic hydrological unit for planning and development of water resources. There are 12 major river basins with catchment area of 20000 km^2 and above. The total catchment area of these rivers is 25.3 lakh km^2. The major river basin is the Ganga-Brahmaputra-Meghna, which is the largest with catchment area of about 11.0 lakh km^2 (more than 43% of the catchment area of all the major rivers in the country). The other major river basins with catchment area more than 1.0 lakh km^2 are Indus, Mahanadi, Godavari and Krishna. There are 46 medium river basins with catchment area between 2000 and 20000 km^2. The total catchment area of medium river basins is about 2.5 lakh km^2. All major river basins and many medium river basins are inter-state in nature which cover about 81% of the geographical area of the country.**There are five classifications.**

9. Troubled Waters

Dr. Zaigham Habib...analyzing climate change and resulting floods in July 2015

Pakistan faced the worst floods in its history in 2010, affecting 20% of its land and 20 million people, and caused a gross economic loss of $9.7 billion. Flash floods, overflowing eastern and western tributaries of the river Indus, and breaches of its embankments affected all four provinces. About 1,780 people died, mostly in the northern areas of Pakistan. In the last four years, floods have caused losses of $2 billion annually. This year's floods have already caused bigger damages.

Since 2003, Pakistan has had a monsoon flood every year. Khyber Pakhtunkwa and Gilgit Baltistan suffered flash floods in 2007, 2010, 2012, 2014 and this year. Balochistan had floods most of the years since 2003, caused by hill torrents, the flooding of river Indus, and cyclones. A cyclone killed 380 people in 2007, while the Indus river was flooded in 2005, 2010, 2014 and 2015.

River floods and hill torrents caused losses in Punjab in 2005, 2010, 2014 and this year.

Sindh had more than average rains in 2003, 2006, 2007 and 2009, causing inundation in lower Sindh, coastal areas & Karachi. The large floods of 2010 caused heaviest damage in Sindh, followed by exceptional rains & damage in 2011. More than 10 million were displaced during these two years.

Drought conditions and heat waves occurred in June in 2010 and 2015. Then, a forecasted weak monsoon turned into a cloudburst, flash floods and uncontrolled rivers. Regular floods over the last 6 years show increased uncertainty of prediction. There are no improvements in flood control, increased inundations, higher infrastructure damages, more and more evacuations and higher economic costs.

Climate change trends can be exploited to help the people and the economy.

The increasingly lost resilience of the waterways and flood prone areas on one side and the inability to take effective flood and damage control measures on the other, show a bleak picture of the future. After the mega floods of 2010 and exceptional rains in 2011, the Punjab and Sindh governments spent billions of rupees on the improvement of barrages, dikes and drainage systems. The impact of these investments is not visible on the ground. That is leading to a perception that floods in Pakistan are an unavoidable disaster, and we should focus on improving response and rescue operations.

However that is not correct. Most of the recent floods are manageable and the good news for Pakistan is that the current climate change trends – although not fully understood – can be exploited for the benefit of the population and the economy. Ofcourse, that is not easy work, and there is no single strategy that would work in all situations.

9.1 Chitral and Northern Areas:

It remains to be understood what makes the stormwater runoffs in Chitral so intense, and why flood tides follow unexpected paths. The meteorological office's interpretation is that heavy rains spread to the drier regions of the valley, generating flash floods. The cloudburst of 2015, they believe, is caused by the orographic rains – where dense clouds collide with the mountain sides. However, hourly rain data available on the Met office website does not show cloudbursts.

The situation report of the Provincial Disaster Management Authority (PDMA) says contribution from the Glacial Lake Outburst Floods (GLOF) are responsible for the runoffs. The UN has recently finished two projects on GLOFs in Chitral. UNDP's inventory shows that the district hosts 487 glaciers and 187 glacial lakes, with 4 to 5 meters of annual glacial melt. There is no information about the quantities of flows caused by the expected GLOF events, their triggers factors, and their link with rainfall.

One can imagine that the Met office will blame lack of monitoring stations and data for the "uncertain and generalized" weather predictions starting from early summer. A mild monsoon was expected this year. It is time we accept that we do not know the behaviour of glaciers and glacial lakes in the Northern Areas of Pakistan. How can the rains increase the snow or glacier melt and trigger additional outflow? We do not have data on rainfall-to-flood-runoff relations for Chitral, or any other northern district.

The damage to the six water supply schemes and five hydroelectric power stations shows that environmental assessment was not properly done for these projects. Other reports say the Galion hydroelectric power project, which was washed out, was installed at the lower end of 26 glaciers.

The effects of deforestation are obvious from the way soils have been washed. Landfalls and debris flows with water have been high. Land sliding and land erosion occur virtually everywhere.

The way the water streams eroded the banks, expanded or changed their paths, and washed out bridges and entire villages, is dangerous for any hilly terrain. The existing streams need widening, removal of encroachments, and bank strengthening. Land consolidation cannot be postponed as a long-term measure.

Each village needs protection and flood diversion structures – a practice used for the smaller groups of houses, and abandoned with unplanned expansions. Instead of a provincial master-plan, each district needs land use and protection measures implemented before the next floods.

Pakistan is severely water scarce, highly disaster prone and poor in water governance

Rod Kohi floods:

Another sign of warning is increasing losses from hill torrents, or Rod Kohi. Such torrents from the Sulemanki Range cause perennial flood disposal problems. The local drains andNallas of DG Khan, Peshawar, Sindh and other areas are abused in many different ways. Their water is used for agriculture, their banks are used for business, houses are built on summer water paths, and garbage is dumped inside or along the banks.

The sanitation department and drainage agencies are responsible for the misuse of these waterways. Unauthorized diversion structures are built on the large flood drains – sometimes in hundreds. These unplanned interventions increase the risk of local flooding.

Large displacements and damages along Indus:
After heavy investment on river structure following the floods of 2010 and 2011, extensive inundation and evacuation occurred during the low and medium floods in the river Indus. About 500 villages have been flooded, and half a million people displaced (Relief News, 27th July).

Most of the flood losses in the riverine area (kacha belt) are avoidable. A post-2010 inquiry tribunal of the Lahore High Court produced a detailed report on the causes of river breaches – "A Rude Awakening". The report suggested many legal and technical measures, but unfortunately, the government could not find a way to implement them.

The first and the foremost problem is that the actual demarcation of riverine areas does not exist any more. The land has been allotted to individuals and departments. There are terms like "kacha" and "pakka kacha". Practically, Kacha is managed by thousands (perhaps millions) of users and there is a variety of vested interests of individuals and departments.

To control such flood damages is really easy:

i) No settlements should be allowed inside floodbanks, especially within the active areas of medium floods.
ii) All departments should be banned from installing public infrastructure inside the floodbanks, especially water supply schemes.
iii) Only seasonal crops should be allowed in kacha areas with a commitment from the farmers that damages will not be paid from taxpayer money. Kacha dwellers are already freeriders in the use of water and outside any tax net. The damages inside the kacha areas are not unexpected "disaster losses". The federal government should not take responsibility for these losses.

Based on the pattern in the last 10 years, we can expect medium floods in Ravi and Chenab every year. Housing schemes and infrastructure along these rivers should be beyond the "medium flood zone".

Inundation between Guddu and Sukkur barrages during medium floods (between 300,000 to 400,000 cusecs, against a capacity of 1.2 to 1.4 million cusecs) rings alarm bells. The flooding close to barrage ponds and upstream cannot be blamed on nature only. An inundation would occur if floodbanks are broken or barrage gates do not release sufficient water, raising upstream water levels. During this year's floods, time lags between barrages have so far been close to expectations. Longer time lags in the past, especially in 2010, caused major water accumulation within the river reaches.

The Indus is one of the few large basins of the world where the operating agency is working without any operational optimization and flood model. The one developed by foreign consultants of WAPDA and NESPAK became obsolete in 2010.

Flood prone areas of Punjab:

More than 500 villages were inundated and more than 200,000 acres of crops were damaged by floods this year in Layyah, Rajanpur and Rahim Yar Khan, including more than 30,000 acres of cotton and sugarcane, according to the Punjab PDMA. The inundation continued on July 27, as a second tide of high flows (about 450,000 cusecs) arrived in Indus. According to a Relief-web report on 25th July, inundation of these areas is normal and the population is usually evacuated before floods. Some of the creeks start swelling when the discharge in Jhelum goes to the level of 200,000 cusecs.

The shallow and wide river reaches at the Jhelum and Chenab's confluence with Indus are traditionally not provided with high floodbanks. The summer flows here are a good source of groundwater recharge, which is extensively used in winter. With the passage of time, tree cover has disappeared, and flood-prone areas have been used for settlements and farming. Some of these locations provide a unique

opportunity to Punjab to develop large wetlands providing cushions to the floods and sustainable groundwater recharge.

Urban inundation:

Urban drainage failure occurs even in case of normal rains in Pakistan. Cities like Karachi, Lahore, Peshawar, Rawalpindi, and Hyderabad, face severe drainage problems.

The situation is worsening with new development projects, which create new low lying areas, consume the capacity of the existing system, or obstruct natural evacuation paths. New housing societies and slums add to the sewage quantities, without extending the drainage network.

Managing the basin with overwhelming climate change:

A professional discussion about basin-level water management has become painful. In global literature, Pakistan is severely water scarce, highly disaster prone and among the lowest performing in water governance (ADB, 2014). Our existing water availability is about 1,200 cubic meters/capita/annum. But 70% of this water is available during threemonths and 30% during nine months.

All provinces and water users face water stress during eight or nine months, and floods during two months. All municipalities face drinking water shortage, even during floods. Hepatitis is becoming an epidemic, particularly in freshwater areas of Punjab, as the ground water is heavily depleted and being polluted with all type of waste. No water reaches to the tail end of river Indus for eight months. A study by the FFC and World Bank recommended continuous flows released from the Kotri barrage to protect the mangroves and theecology of the Indus delta. A demand for the environmental flows is often raised.

But where will this water come from? By transferring only 30% of flood flows to winter, high and medium floods in Indus can be converted into medium and low floods respectively. The only cheap electricity resource for Pakistan is hydroelectric power. By storing just 30% of the flood flows, the existing power shortage can be addressed.

Thus, water resources and floods in Pakistan can be managed with substantial economic benefits. The question is, when will the country start taking serious steps?

Dr Zaigham Habib is an independent consultant on hydrology and water resources. She has carried out modeling studies of the Indus Basin to analyze water distribution, agriculture performance, environmental flows, rainfall runoff and hydraulic improvement of the LBOD drainage system.

10. INDIA'S SURREPTITIOUS WAR FOR ALL TO SEE. CLOSED DOOR CONFERENCE NEW DELHI (2010)

(Appended IWA-7, Chenab Charts& Times of India article July 2010)

Suleman Najib Khan

Kashmir is the source from where the bulk of Pakistan's waters originate. India annexed Kashmir after the Sikh ruler opted for the Indian Union. The myth of "Democratic India" can be annihilated on this one terrible development alone. Pakistan's half-hearted military campaign was easily sabotaged through its British commanders. Pakistan was after-all a protectorate of the Empire for the first 10 years. The promise of plebiscite was never sincere; always a bluff. The 13,300 square kilometers of AJK (Free Kashmir) was liberated by the tribal militias sent by the NWFP provincial government. The Northern Areas of GB were liberated by an English major with the help of locals. Understanding that Kashmir is the source from where the bulk of Pakistan's waters originate, it is a terrifying fact that India managed to annex Kashmir. Therefore, in one annexation, India took control of Pakistan's "lifeblood," its water-sheds. It is not difficult to understand why it did so. History has consistently proven that civilizations and nations can thrive only if their "sweet water" resource is plentiful& secure. In essence, our prosperity, our economy, our very existence lay firmly in the hands of our rival state. Furthermore the Indians knew that Pakistan's major asset is the Indus Basin Irrigation System (IBIS) and its citizens have a long tradition of agriculture. Water was the weapon by which "Mother India" would take its revenge from those who "violated her" in 1947.

India used the "water weapon" (its water advantage) in 1948 against all norms of civilized behavior and international laws governing sharing of waters by neighboring states. The first nation that sensed the gravity of the situation was the USA and they acted quickly. Several initiatives were taken directly by PAK officials to convince the Indians not to put into practice their threat **"to starve Sindh & Punjab….. (and)….. would have to beg for every drop of water"**. As Mr. Bashir A. Malik writes in his book (Indus Waters Treaty in Retrospect) the East Punjab government had made it clear that: **"(It) would not restore the flow of water to the canals unless West Punjab acknowledged that it had no right to the water".**

A hard-headed American public official, David Lilienthal was one of the three directors of the Tennessee Valley Authority (TVA), that undertook the mega project of providing irrigation, floodcontrol, electricity generation, fertilizer manufacturing, and economic development in the Tennessee Valley, which was an area especially hard hit by the Great Depression. President FD Roosevelt when faced with the aftermath of the 1929 market collapse had to highlight & exploit USA's unutilized potential under the "New Deal". He correctly decided that seven contiguous States had the water resources and the land. The TVA was launched and an institute was created in Mississippi where the best available talent amongst military and civil engineers was brought together. A series of 26 dams and associated irrigation channels as well as flood control structures in addition to malaria control & fertilizer production were included in the program. The project stimulated the entire US economy and ***TVA remains a priceless jewel of the US economy.*** The TVA was built on one guiding principle: affordable power for everyone in the Tennessee valley. After its glaring success, Lilienthal was hailed as the "father of public power," and under his leadership, the TVA became the ultimate model in efforts to modernize Third World agricultural societies. TVA was the model for WAPDA's creation in 1958 during President Eisenhower's Administration but today WAPDA is not being allowed to fulfill its potential. Let us recall these two passages in David Lilienthal's report delivered to PM Liaqat Ali Khan by Mr. Eugene Black, President IBRD/World Bank with his letter of 06 Sep 1951.

Quote:

"Why the flow of the Punjab's lifeblood was so carelessly handled in the partition no one seems to know. Pakistan includes some of the most productive food-growing lands in the world in western Punjab (the Kipling country) and the Sind. But without ***water for irrigation*** this would be desert. 20,000,000 acres would dry up in a week, tens of millions would starve. No army, with bombs and shellfire, could devastate a land as thoroughly as Pakistan could be devastated by the simple expedient of India's permanently shutting off the sources of water that keep the fields and the people of Pakistan alive"……..

The report also stated,

"The partition gave the major part of the irrigated lands of the Punjab and Sind to Pakistan; but the headwaters of some of the largest irrigation canals that feed Pakistan were left with India or Kashmir. All the rivers upon which Pakistan depends for life originate in India or Kashmir. ***Two thirds of the entire water supply originates in Kashmir where the snow-fed Indus rises".***

Unquote

Therefore with annexation of Jammu & Kashmir she created the basis for the gradual control of three western rivers flowing through it. Her barbaric interruption of the three eastern rivers immediately after partition was cold blooded and one wonders at the mindset of the Indian leadership as India's brutal & inhuman squeeze increased immediately after the passing away of the father of the nation in 1948. While the Pakistan Leadership repeatedly failed to appreciate & predict the Indian strategy of damaging Pakistan's incipient economy using this mortal water weapon, the fifth column internally became active in every sphere of economic activity.The anti-dam lobby became increasingly vocal beginning from the Anti-partition group of Walibagh, KP. The nonsensical propaganda that said dams can create floods is incorrect on every technical and realistic front. Dams do not create floods; they control floods. More dams by definition mean more regulation. It is important to note that Pakistan wastes at least +30MAF of water to the sea after allowing a reasonable quantity of 10MAF annual flow into the sea to meet the environmental requirements (survival of mangroves, coastal fish life and to ensure zero sea-water intrusion). Additionally, why should capillary action of 40 ft be imagined against all laws of physics? The lowest point of KP at 955 ft is 40 ft higher than design of Kalabagh Dam (KBD) max crest level. Secondly, the rise of the Sindh anti-dam lobby became visible after the birth of Bangladesh. Its roots lie in Walibagh and it uses exactly the same strategies previously started. This is truly ironic since Sindh needs fresh surface water more desperately than the Punjab because the former has negligible sweet water aquifers. The concerns of the Sindh activists should have been satisfied towards KBD as ISO-14000 Environmental Studies by IBRD were found absolutely satisfactory in 1987.

The IWT 1960 was signed at Karachi on 19 Sep 1960 by PM Jawaharlal Nehru & President Ayub Khan. WB was facilitator & guarantor. Rivers sustain civilizations, not just communities. The weakness of perception in understanding this one fact has created a right mess of things in the nation on every economic front from the energy crisis to provincial disharmony. Do we analyze the loss?Alarming reduction in Indus Basin waters continued during 2008 and this in tandem with the criminal interruption of Chenab Main during the flood season of August & September '08 as Indians were filling the Baglihar-I storage on Chenab river in IHK. The quantify of water flows into Pakistan is decreasing, I estimate that the Indians have increased the diversion of Kashmir waters by over 3MAF annually during the last several years. Flow data estimates that Indians could exceed 50MAF diversion after accounting for additional flows caused by global warming/glacier retreat. The Indian organization "International Commission for Irrigation & Drainage" established in 1950 has developed an "India First" agenda and positioned itself in a position of great influence with multilateral institutions & government agencies worldwide. ICID is a dangerous weapon. Jinnah's advise about Kashmir being the main life sustaining artery of Pakistan must now be appreciated by his nation or face extinction. The Indians clearly understood Kashmir's strategic value; "the end justified the means".

David Lilienthal's report is an exceptionally unbiased & professional commentary on the inequitable distribution of hydro assets in 1947 by the Imperial rulers. The potential for Indian aggression makes it

an eternal message for the Pakistani nation. The report did not recommend the surrender of three Eastern rivers to India, yet tragic blunders were committed by Pakistan in the negotiation of the Indus Waters Treaty 1960. Does India now consider this treaty relevant? Through ICID & otherwise the Indians now oppose every effort to secure multi-lateral financing for large dams. It has the audacity to declare the Northern Areas of Pakistan as part of greater Kashmir to ensure that IBRD/WB may not fund infrastructure projects under its Greater Kashmir policy.I estimate that the Indian factor; its interference in our Indus Basin flows (directly & indirectly) has already inflicted a loss of over USD one trillion on Pakistan's nascent economy. This loss will now grow exponentially because the loss has snowballed into an energy crisis resulting in a catastrophe for our industrial & commercial economy. Each MAF Pakistan does not utilize is around USD 2 bn loss to the economy directly & indirectly. An annual loss of USD 60 bn is estimated since 2004. The Hydel to thermal ratio has become 30:70, which is completely lopsided as the ratio of 70:30 was declared the national electric energy objective! Ideally a zero thermal energy policy could be pursued but Indus basin flows are having extreme variations; some years more than 33 times from minimum to maximum. Therefore an unavoidable element of 30% thermal energy was determined after great reflection & analysis. The following is a detailed summary of all thus far mentioned:

a) India created a major water crisis in Punjab during 1948 bringing Pakistan under great economic distress. The US Administration reacted. President Truman ordered an irrigation expert to review the situation. Mr. David E. Lilienthal was deputed in early 1951. Within six months after touring India & Pakistan he published his report. Between 1951 and 1958 the US Administrations took a keen interest in water issues. The Eisenhower administration helped create WAPDA based on its most successful TVA model. Pakistan's Indus Waters delegate to Washington DC Mr. G. Mueenudin played a mysterious role in the final Indus Waters Treaty negotiations. He convinced the PAK Government to accept the last minute amendment in the IWT draft allowing India to lay claim on additional water for future agriculture in IHK. Water quantity was not determined. Above all Pakistan agreed to the exclusive use by India of the three Eastern Rivers (Ravi, Beas & Sutlej) giving away some 33 MAF flow; about 20% of its surface waters to India. Mangla Dam on Jhelum was quickly completed. World Bank was committed to finance one major dam on the Indus. Tarbela Dam was selected by Pakistan as the major replacement infrastructure for the three Eastern rivers granted to India. The objective being to keep the Link-Canals fed so that the Ravi & Sutlej rivers could be kept alive inside Pakistan territory. A major link canal (Chashma-Jhelum) was included in the replacement works. All this revolved around new reservoirs but their construction after Tarbela Dam were sabotaged. Who benefited?

b) Let it be understood that Pakistan has not built any reservoir since 1974, which was the year Tarbela Dam was commissioned. It is perhaps the only developing country in the world which has been shy of building a dam. This is in spite of the fact that it is a pre-dominantly agricultural country with its irrigation system being its greatest asset. The March 1991 Water Apportionment Accord between the four provinces acknowledges that 22 MAF is available for storage without damage to the ecology. This means three Kalabagh size reservoirs are possible and this availability figure increases as existing storage capacity reduces due to sedimentation. It also stipulates that from any new reservoir the share of the Punjab would be 37%. The share of Sindh inspite of one-third population (compared to Punjab) is also 37%. The share of KP stands at 14% and the share of Baluchistan 12%. This Water Accord is a most realistic document but the two lobbies in KP & Sind block its implementation.

c) In 1974 Pakistan had achieved a cumulative storage of nearly 17MAF based on its three main dams and the Chashma barrage, which also stores about 1MAF. Today it is below 12MAF and falling whereas the population has increased by nearly 100% since 1974. The 2015 scenario points to a depleted storage of 11MAF for a population that would then be around 190 million. In the spirit of the Water Apportionment Accord 1991 at least one major reservoir was required on the Indus as a replacement reservoir, so that the depleted capacity can recover to the 1974 level (but alas for twice the population). KBD site was declared the best by WB in 1983

&satisfied ISO-14000 requirements in 1987. What logic can possibly be used by the anti-dam lobby against the creation of a replacement reservoir unless it wants to mortally damage the functioning of the IBIS already water short since the last 20 years?

d) Over 21 million acres of potential cropland stays virgin & fallow. Triple cropping is impossible now on the 42 ma of irrigated land. Expensive electric pumping or diesel engine pumping is not a perfect answer. Indus Waters Treaty 1960 is now in jeopardy as India, the upper riparian threatens to amend it under international law. Although World Bank is a guarantor of this agreement, we should have serious apprehensions. Indians refer to the rights of the upper riparian when the lower riparian does not use the water for thirty years. The IWT is sacrosanct. Maynot be amended unilaterally.

e) The concerns of Sindh seem to be increasing every year due to a simple reason. There is less water in the rivers and "the Sindhis" are told that this is the fault of the Punjab. These accusations will become more serious as there will be less water every year. Sindh has to realize that its underground water is generally not useable and surface water is therefore its' salvation. The two months of monsoon or flood season will feed the reservoirs that will keep the rivers flowing for the next ten months. The poverty cycle cannot be reversed without the re-vitalization of the IBIS (Indus Basin Irrigation System). It is a machine worth at least USD 700 billion (today's replacement value) and is simply water short. Lining its water courses and distributaries is a pittance and is feasible only if the subsoil water is saline otherwise normal seepage recharges aquifers and is not lost. Reservoir capacity is the core issue.

f) The surface flows from the three western rivers are reducing every year. Refer to Annexure-C, "CIBSA response to ICID challenge" states, the Indians are increasingly diverting waters from IHK. Why is it that the extra flow due to global warming is not being reflected? Every year we receive lesser surface waters. The unbelievable reduction of Chenab Main from 1983 upto 2008 at Marala Headworks (entry point) is available through appended four charts. The Indian commitment to ensure 55,000 cusecs in Chenab at Marala is now a mirage as since years the average flow does not cross 18,000 cusecs. India suddenly released some water on 18 May 2009. For a few days, after many years, Chenab touched 30,000 cusecs flow. Perhaps we managed to provoke India to an extent that she released water into the Chenab during this time. In Kashmir Chenab waters diversion to Ravi in East Punjab is no engineering problem for India. India's water war is surreptitious. Indian statements that she only uses occupied Kashmir waters for "run of the river" power generation is a blatant lie. Is she willing to let neutral experts of World Bank & other agencies to monitor the inflows into all her infrastructure projects in held Kashmir? Why is it that she needs storages for these "run of the river" projects? Even one day's reserve is sufficient. Of course she will never agree to provide us with the inflow data at Baglihar I. We only know what comes downstream (outflows). The withdrawals are her state secret. It is clear why she has built or is planning to build 171 Infrastructure projects in occupied Kashmir. There are strong reports of tunneling as well. India admits that Kashmir projects will generate 28,000MW. Through it all, the Pakistani bureaucracy continues to sleep. **The politicians of all shades are ignorant.**

g) Let us understand that global warming & subsequent glacier retreat is an undeniable reality. Based on historic and current data, I estimate that the inflow of Indus, Jhelum & Chenab should have increased by +40 MAF for the next 20 to 40 years. India does not divulge; by diverting Kashmir waters she denudes Pakistan & enriches India. In 2006, India launched the World's largest single irrigation project estimated to cost over USD 212bn. This River Linking project based on the Prabhu Report is clearly predicated on the theft of Pakistan's waters flowing through IHK. CIBSA must help us understand and then educate the world about this dangerous enterprise. India had by 2003 already achieved more than 250MAF storage representing more than 30% of its surface flows and with this so-called River Linking project she will cross 40%.

Appendix-1(IWA-7 documentsent to New Delhi before the Closed Door Conference of 29 – 30 July 2010)

"A PREAMBLE TO THE INDO – PAK WATER WAR"

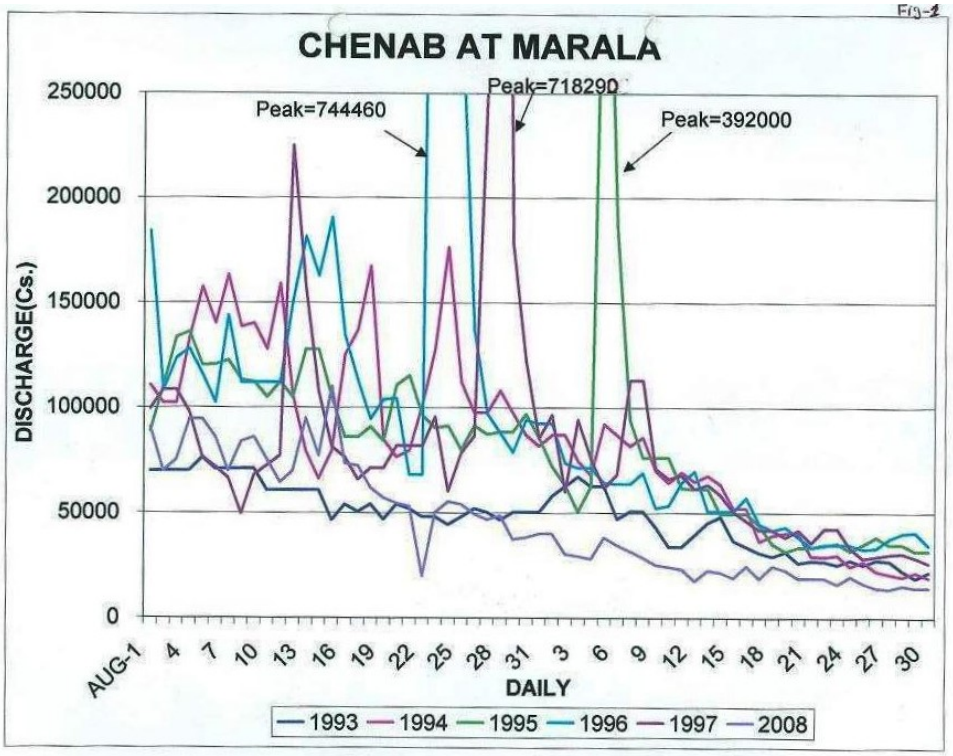
India's water war is no longer surreptitious. It is blatant. It is now a cold-blooded campaign. Her transparent interference internally in Pakistan has created an anti-dam lobby within the three smaller provinces. Their open opposition to a second reservoir on the Indus after commissioning of Tarbela Dam (1974) has been suicidal for Pakistan's economy. Punjab, Pakistan's largest populated province and breadbasket has seen its agricultural output stagnate. No thanks to Pakistan's rising population the per-capita agricultural output has fallen in real terms. Poverty & the resulting tensions within the Federation have multiplied. India's internal factor (in Pakistan) & external activities (in Kashmir) have inflicted upto 2010 a financial loss of over a trillion USD equivalent to the PAK economy & it is growing. Due to Pakistan's failure to build multi-purpose dams the desired hydel:thermal ratio has become lopsided; around 30:70. Imported oil based power generation is not financially sustainable for the PAK economy.

India now goes ahead with plans to build 100 + hydro-electric projects on Pakistan's waters flowing through Indian Held-Kashmir. These are the so-called three western rivers: Indus, Jhelum & Chenab. She uses a benign concession in the landmark Indus Waters Treaty of Sep 1960 to justify building dozens of high dams & creating reservoirs in cascade on all three. Instead she could build non-controversial run-of-the-river hydro-electric power plants (using diversion thru weirs & power tunnels) that return the water flows to the river concerned. Equally disturbing is India's claim on the waters that Pakistan's anti-dam lobby compels it to waste. Pakistan is already since several years facing the inexplicable scenario of drastically shrinking inflows from her western rivers. The hydro based infrastructures being constructed by India in Kashmir permit her absolute control of the surface flows into Pakistan besides creating the capability to divert Kashmir waters into the northern Indian basin. India is building the world's largest single irrigation project stretching from the Indian Punjab (in the west) to Indian Bengal (in the east). A blueprint for history's greatest genocide is unwittingly under implementation?

The tragic symptoms of irrational behavior among Pakistani youth including the bizarre & murderous mission to Mumbai by ten odd PAK militants in Nov 2008 are signs of a despondent people. Such missions will escalate exponentially as a nation comes in the throes of an economic suffocation orchestrated by its upper riparian neighbor. Inhuman policies can bring out inhuman reactions. A sad analogy of Newton's third law of motion. Indian maneuvering & high handed tactics before the IWT 1960 got them the entire flow of the three Eastern rivers. It was historically an unprecedented & anti-civil milestone. Equally unforgiveable was that the Pakistani leadership had acquiesced. Today, Pakistan's second largest city Lahore is sinking in its sewage as its life sustaining Ravi river has become a sewer. It's ever deep water pumps throwing up arsenic & nitrates far beyond safe limits. The anti-dam lobby has ensured reduction of Pakistan's storage capacity to about 8% of its annual surface flows of 145 MAF. A deadly fifth column exists which the nation has failed to cleanse. Pakistan is economically choking due to its water stressed situation. Yet the Indians project themselves as the aggrieved party.

Our mission should be to focus Indian & world attention on the spirit of the Indus Waters Treaty 1960 so that violations & transgressions are totally eliminated ab-initio. Indians must become good upper riparian neighbors. Renegotiation of the IWT 1960 is not possible because the Indians will not discuss the ownership of the three Eastern rivers. It is the best we can have in an imperfect world. Indian official strategy is leading to history's greatest genocide & they must be reversed for the sake of all people in the region and beyond. Mr. John Briscoe correctly hopes for an Indian Mandella. Let us all sincerely pray for one before it is too late. Amen.

Appendix-2: 4 x Chenab Charts shown to the Indians (a clear voilation of IWT-1960)



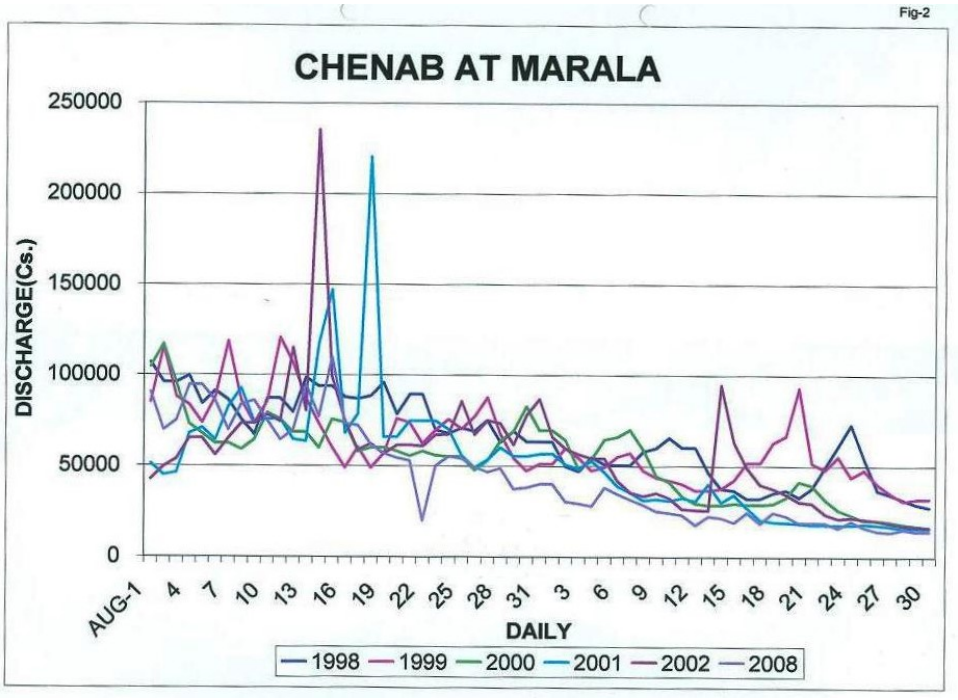


Fig-3

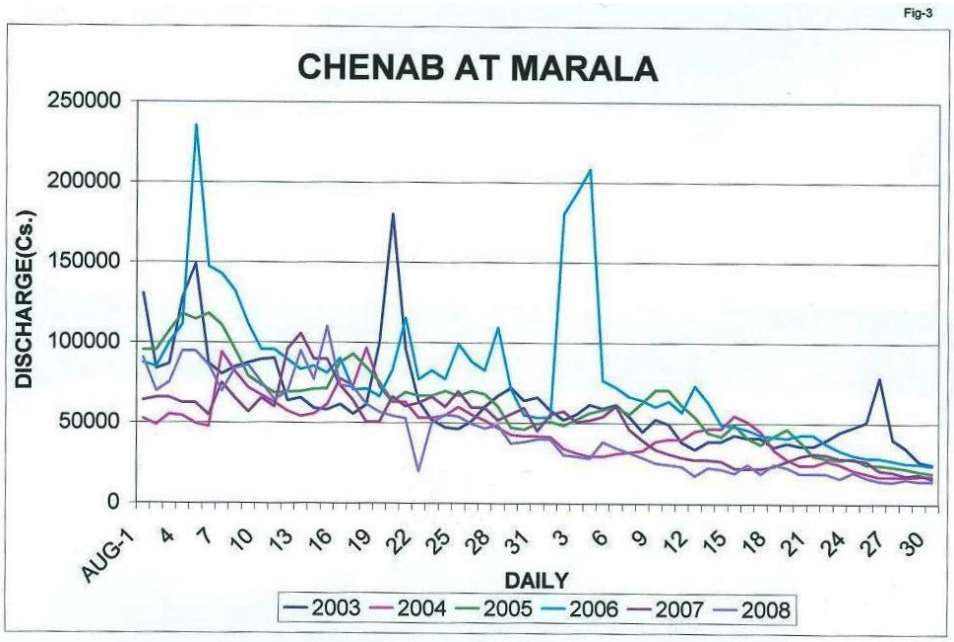
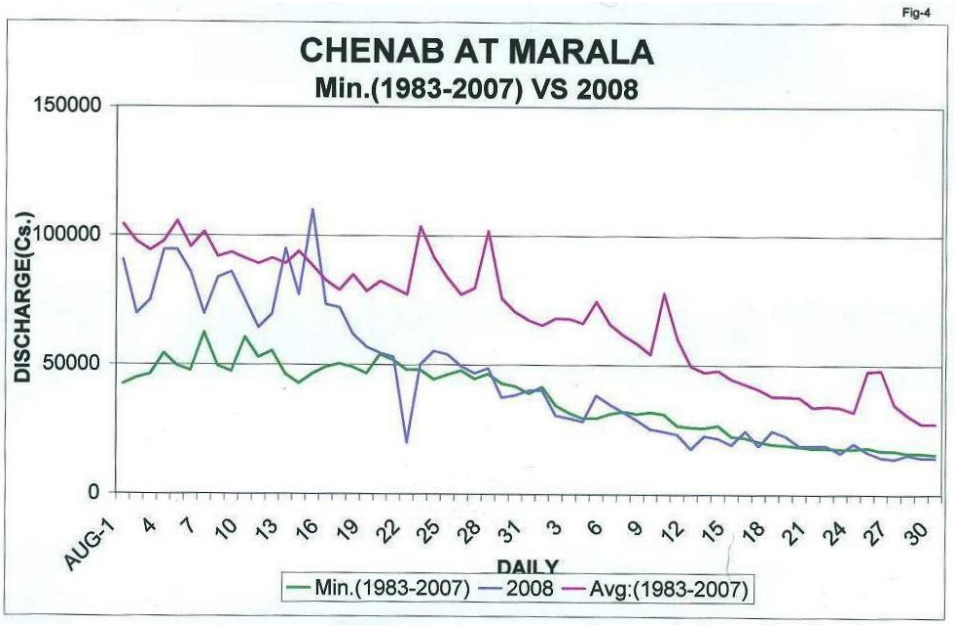


Fig-4



Existing major reservoirs on Chenab& Tributaries in IHK upto 2014:

- Sallal Dam live storage 58,000 AF, max design discharge 792,000 c/s, 690 MW.
- Baglihar I + II storage 164,000 AF, max design discharge 583,000 c/s, 900 MW.
- Dulhasti (HEP) manipulative storage 6,485 AF, discharge 282,500 c/s, 780 MW.
- Lower Kalnai (HEP) manipulative storage 616 AF, powergen capacity... 48 MW.
- Rattle (HEP) manipulative storage 19,340 AF, discharge 48,777 c/s,....850 MW.
- Pakal Dul Dam storage 88,000 AF, design discharge 207,976 c/s,.....1,000 MW.
- Miyar (HEP) manipulative storage 13,000 AF, discharge 29,378 c/s,.....120 MW.
- Additionally there are 10 HEP in operation, total storage +0.25 MAF.
- Additionally 03 HEP & Dams under construction including Sawalkot 1,500 MW.
- Additionally 56 HEP & Dams are under construction. Therefore India violates the IWT 1960 because she knows that Pakistan geography does not permit a major dam on the Chenab River downstream of Marala Headworks.

THE TIMES OF INDIA, NEW DELHI
SATURDAY, JULY 31, 2010

Water Boiling Over Across LoC

Terrorism is the main discordant note in India-Pakistan ties and is at the heart of the trust deficit. But threatening to spill over is another issue — water. As part of Aman ki Asha and backed by Delhi-based Centre for Dialogue and Reconciliation, experts from the two countries met on Thursday and Friday

Misperceptions and not facts dominate the debate on water across the border. Pakistan's green belt draws its sustenance from rivers that flow out of Jammu and Kashmir. Now, more than 60 years after these waters have been peacefully shared, there are mounting accusations that India could choke this supply line by building a series of dams.

aman ki asha

Sitting across the table for two days, top water management experts and irrigation engineers from the two countries discussed the issue, often with a degree of rancour, if only to understand each other's positions as a starting point on a journey to cool the debate that some hawkish commentators have suggested could lead to war.

At the centre of the debate was naturally the 1960 Indus Water Treaty that governs the flows into Pakistan and provides an agreed dispute-resolution mechanism. In recent months, the buzz in Pakistan has been that India is building more than 100 dams on the Sutlej and Chenab and this will deplete supplies to farmlands that feed Pakistan's 180 million people. While some Pakistani experts stuck to that position, most appeared convinced that India was not violating the IWT by building these dams and what was planned were a few dozen small projects, called run-of-the-river, which wouldn't obstruct flows but only divert them for a short stretch to run power turbines.

The meeting coincides with a new row over the 330mw Kishanganga hydroelectric project in J&K. India and Pakistan, after failing to resolve it within the IWT, agreed to international arbitration with the UN secretary-general selecting an umpire.

"There is no drying up because run-of-the-river projects deplete water only at filling time of new dams. Whether there are 50 or 100 it doesn't matter. You can't store running water," said B G Verghese, a water expert associated with the Centre for Policy Research.

> Pakistanis are fed the fear by Hafiz Saeed and politicians that water will be used as an instrument of war

Others like Ramaswamy Iyer, former water resources secretary, agreed with Verghese that while neither India nor Pakistan were models of water management, there was no data to show that New Delhi was cheating on the Indus agreement. In fact, experts from both sides said there was no data available to shape a reasonable debate guided by facts.

To this end, the conference urged both countries to jointly plough for data and make it public so that the existing fog clears. Joint mechanisms to measure water flows into Pakistan, as in the case of Bangladesh, could remove mistrust, they said.

The conference, like previous ones on strategic issues and the media, was structured around a series of closed-door sessions featuring presentations and open discussions.

Beyond water-sharing, discussions went into issues relating to environmental and ecological challenges in the Himalayan region, as well as cooperation in watershed management.

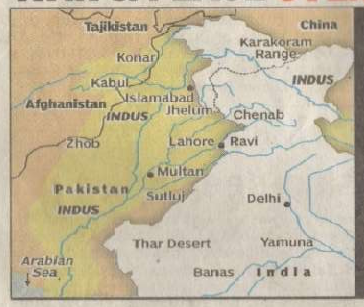
Photo: Sanjay Sekhri

BREAKING ICE (From left to right) An NGO activist looks on as Suleman Khan, an engineer from Pakistan; Khalid Mohtadullah, a Pakistan water expert and Ramaswamy Iyer, former water secretary, India, deliberate

Recommendations

- Make water flow data public
- Monitor flows jointly
- Jointly study factors for depleted flows

WAR & PEACE OVER WATER



A map showing Pakistan's river system and how it originates in India (left); a map of Europe shows how several countries share the Rhine river without hostility

11. A RELENTLESS UPPER-RIPARIAN PREDATOR. LESSONS OF BANGALORE (2014)

Suleman Najib Khan

11.1 Lessons of Bangalore (16 & 17 Feb. 2014)

i) The Indian position has hardened since my last interaction at the "Closed Door Conference on Kashmir Waters", New Delhi (29 & 30 July 2010). Refer Chapter 10.

ii) The Indian side does not show any willingness to share hydrological data of IHK. A consistent & basic violation of the IWT 1960. They insist that global warming /glacier retreat has reduced the ice mass but there is no additional flow (absolutely illogical). This was the position taken by Prof. Shakil A Romshoo, of the Department of Earth Sciences, University of Kashmir, Srinagar. He circulated his book on the cryosphere.

iii) We always understood that ground water (GW) is part of the same river valley. It is indivisible from the surface waters (SW). Therefore their position that IWT 1960 did not divide the GW resource is cynical. Their senior team leader Mr. Ramaswamy Iyer made a profound statement when he retorted that **"the IWT 1960 was the second partition of the sub continent and it is a limited agreement"**. He was responding to my comment about the short comings / flaws in the IWT 1960 with respect to the latest science of ecology. They do not want to discuss environmental flows. Absolutely not. They are now moving to maximum exploitation of the IHK aquifers by using cheap power that they will generate from the 171 HPP they are creating. Is this not a Genocidal mindset?

iv) The Indians insist on talking about an additional 3.6 MAF permanent storage as per Annexure-E of the IWT 1960. Therefore I have explicitly pointed out at Bangalore that they are already close to a conservation storage capacity (general storage, power storage, flood storage) of around 3.60 MAF, the aggregate storage capacity permissible in IHK at any "Delta T". To my surprise Mr. Ramaswamy Iyer retorted that 3.6 MAF would be the **permanent storage** permitted to India on IHK projects. Another bluff from a bully. He should have known that the cumulative storages of a cascade (of reservoirs) represents a "live storage".

v) The questions often asked to the Indian side but never replied are:

- Is India willing to allow neutral observers to study the IHK hydrology?
- The IWT 1960 does not permit diversion of Kashmir waters. Infact only non-consumptive use beyond what is allowed for irrigation & power for the use of local population of IHK. How many HPP & dams could India construct in IHK without interrupting the natural flows & the timing of flows?
- Is India willing to clarify why she builds the world's largest single irrigation project (the NRL) at a cost of USD 212 bn equivalent if she has no new sources of sweet water? IHK Waters will be obviously diverted.

11.2 Collaborative Networks & Partnerships for Possible Joint Studies

(The paper circulated at Bangalore Feb 2014).

Quote:
There is indeed a massive "trust deficit" that several roundtables may have partly attenuated but a radical departure of this present format now looks necessary. The Upper Riparian would need to play "big brother" as this issue assumes ever increasing dimensions of its multi-faceted personality. Great power aspirations mean greater responsibilities.

Since the "Preamble" outline paper I sent on the eve of the New Delhi Closed Door Conference (July 2010) there may have been deeper analyses and understanding of the issues but we have not really carried out any joint study in this period inspite of great need. The Lower Riparian complains that flow data is neither available nor accurate and only sporadically received. The Upper Riparian has technologically advanced tools at its disposal and could address this "trust deficit" on the Indus Basin flows. Equally critical for Pakistan is the state of its aquifers south of the Potohar plateau. When man interrupts perennial flows we need certain safeguards to achieve the required sustainability & balance of the aquifers. Unregulated mining of this precious resource continues under compulsion. A great ecological disaster is apparent.

IWT 1960 ignored drinking water needs. It did not foresee major environmental factors which later resulted in terrible ecological damage. The process is ongoing in Central & South Punjab. Can we raise awareness amongst the Indian intelligentsia & men of peace? All is not well in the matter of water cooperation in the Indus Basin. It is the "Politics of Water" gone astray.

Let us look at the new literature from India. Mr. Brahma Chellaney's book "Water - Asia's New Battleground", is a sad example of aggressive intent. His thesis and approach is 180 deg opposed to the talk of water cooperation & sharing of the Indus basin. He is legitimizing Water Wars. Someone should give him a copy of the UN-Water Analytical Brief "Water Security & the Global Water Agenda". The relationship between Water and Human Security is described very clearly. It says that Water is a multi-dimensional issue and a prerequisite for achieving human security from the individual to the international level. Human security is dependent on an individual's sense and level of well being with these being closely tied to the individual's need for water and the benefits it provides. Water security can therefore reduce the potential for conflicts & tensions, contributing to significant social, development, economic & environmental benefits on a larger scale, as well as to the realization of states' international obligations.

Now to the letter & spirit of the IWT 1960. We face a ridiculous "the then" controversy, when uninterrupted & non-consumptive use should be paramount. The fact that the Lower Riparian has intention to use the water must not be ignored. World Bank gave one side the ownership but not the possession. The preamble states "All" & "Unrestricted". Therefore Pakistan has the same rights on these three Western Rivers as India has over the three Eastern Rivers, inspite of the territorial situation. We have observed violent hydrological changes due to Climate Change. We must not fly blind anymore. Pakistan simply has to know the changes in flows of the UIB & HKH region. The terrible floods of 2010 could have been foreseen with better management.

The ongoing damage to the ecology of 8 MA of South Punjab due to the IWT 1960 has indeed driven a great wedge. The Lower Riparian will simply not accept anything less than a joint master study. I am compelled to propose that instead of the "Brahma Chellaney" prophesies we need third party assistance. Both J&K as well as AJK are difficult for either side to access. Perhaps this openness can finally address the "trust deficit" and push both our nations to get down to the task of breaking the cycles of poverty, ignorance & disease. God bless you all.

Unquote

11.2.1 IWT 1960 delusions & transgressions (the demands made at Bangalore Feb 2014)

i. What are the minimum environmental flows into the rivers entering Pakistan for achieving a sustainable water security of its population?

ii. Can we ensure aquifer recharge in this scenario?

iii. Is Indian hydro activity IWT 1960 complaint? Is the upper riparian permitted to interrupt the flow of the Western Rivers flowing though IHK/J&K?

iv. Pakistan is denied accurate flow data of J&K. Is the glacier melt of Jhelum catchment accounted? Can we finally study the watershed in IHK/J&K & AJK and evolve a common management strategy.

Note:

The Indian response is given in the foregoing at 11.1(iii).

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December 29, 2013 News NATIONAL

Establishment starts looking into Kishenganga fiasco

Commissioner says partial verdict by world court is the foundation of ultimate loss

From Khalid Mustafa

ISLAMABAD: There are reports that the military establishment is upset about the international court's decision on Kishenganga and its repercussions on the country's water interests, and at some point questions may be asked about the team which led Pakistan to this debacle.

According to top sources, members of the legal and technical team may face the music over the way the case was fought in The Hague court and more importantly the establishment will go deep into the rationale for appointment of Kamal Majidullah who was alien to the trans-boundary water issues.

Commissioner Pakistan's Commission of Indus Water (PCIW) Mirza Asif Beg admitted that Kamal Majidullah led Pakistan's team in the Hague court till the partial award that came out on February 18, 2013.

When this correspondent tried to contact the ISPR for a formal response whether the GHQ's legal branch would take up the case and look into it, no official was immediately available. However, sources said the way Pakistan's case was handled had upset many in the establishment and they were soon going to look into what had happened.

Kamal Majidullah was the one who managed to get notified the Pakistan Trans-border Water Organization (PTWO) on September 23, 2011 and brought down PCIW under the umbrella of PTWO. Beg said PCIW was bound to directly and exclusively report to PTWO and even Majidullah used to get annoyed when PCIW reported to the Ministry of Finance. Majidullah tried his best to limit the role of PCIW in the legal battle against India.

Beg said the PCIW was even not allowed by Majidullah to report to the parent Ministry of Water and Power. So under these conditions no one was aware in the ministry what Majidullah was doing. Till the partial decision by The Hague court, Majidullah was responsible as he was calling the shots, Beg said.

He admitted that the partial decision was the foundation of the final decision. To a question, Beg said onward from partial decision to the final decision, he himself was responsible for the decision.

When asked why Pakistan's side did not submit data on current or anticipated agricultural uses of water from the Kishenganga/Neelum with The Hague court, Beg said when there was no water use for agriculture from Muzaffarabad to Dau Bhat, how they could submit the required data.

He admitted that the reduced flow of water of 9 cubic meters per second allowed by The Hague would not be enough for maintaining the environment of Neelum Valley. The Hague court's decision was consensus in which the interests of both the countries were compromised. However, on the issue of diversion of water in Kishenganga project, the decision is heavily tilted in favour of India whereas on the issue of drawdown of flushing, the decision was totally in favor of Pakistan.

When this reporter tried to contact Kamal Majidullah, the then special advisor to the prime minister on water and food and Pakistan's agent in Kishenganga case, to seek his comments, he did not respond to any SMS containing the questions: i) What is your view about The Hague decision; ii) Is it true that you are alien to trans-boundary water related issues and what was the rationale of your appointment; iii) Is it right that you managed to bring down PCIW under your contract and it was bound to directly and exclusively report to you and not even to the Ministry of Water and Power and is it also true that you used to stop PCIW from sharing water related information about India with the Foreign Office?

However, Wapda officials are of the view that with the defeat in The Hague court on diversion of water by India in Kishenganga hydro power project, Pakistan is to brave every year a huge loss of $ 145 million for the units of electricity that will not be produced by Neelum-Jhelum (N-J) hydropower project in the wake of massive reduction in water flows. More significantly, in drought conditions as happened in 2001 Pakistan will face a loss of more than $544 million every year.

However, they said a thorough probe should be initiated against Pakistan's legal and experts' team that failed to plead the case in an effective manner of the low riparian country. "And on top of it, the more shocking development is that India plans to construct 10 more hydropower projects upstream Wullar Lake that would inflict more damage on Pakistan's water interests.

When contacted, eminent water and energy expert Arshad H Abbasi, presently associated with SDPI (Sustainable Development Policy Institute) as advisor, said the decision by the international court was a disaster for Pakistan not only for electricity generation capacity of Neelum-Jhelum project, but also for the ecology of the beautiful Neelum valley.

He said Beg does not know the fact that Pakistan continued getting 11 cubic meter per second of water when there was a severe drought in 2001. And in 2001, the pine blue trees got a disease because of low flows of water at Dau Bhat. Now under the decision of The Hague, in normal days when Pakistan will get just 9 cubic meter per second water from Kishenganga, the Neelum Valley whole's environment would be exposed to massive devastation.

Under the diversion of water by India allowed by The Hague court, there will be reduction in water flows by 40 percent of 2.45 MAF and this will adversely impact Pakistan' Neelum-Jhelum Hydropower project's capacity to generate electricity.

12. TRANSBOUNDARY WATERS: PERCEPTIONS & REALITIES

Sardar Muhammad Tariq

12.1 Background

Water disputes between India and Pakistan emerged immediately after the partition of the sub-continent into two independent and sovereign states. This partition unfortunately cut across the already established and well functioning networks of irrigation canals and numerous hydraulic structures with control structures of the Eastern Rivers falling within the domain of India and canal network extending into West Punjab and irrigating some 5 million acres of fertile land. Soon after the partition, India communicated to Pakistan of its intention to divert the waters of Eastern Rivers for its own uses. As the control structures were in Indian Territory, India could do it easily. This meant that the single and only economic base of Pakistan i.e. irrigated agriculture would be left high and dry. This act of India was tantamount to strangulating Pakistan's agro-based economy and igniting the fuse for a major war. The sensitivities of this issue were realized by international communities as well and with the good offices of the World Bank and over a decade of negotiations, Indus Waters Treaty was signed in 1960 between India and Pakistan with World Bank as a guarantor and also signatory to the Treaty. Under this Treaty the three eastern rivers viz. Ravi, Sutlej and Beas were given to India and the three western rivers namely Indus, Jhelum and Chenab were given to Pakistan with limited uses by India.

12.2 Post Treaty Reaction

There were conflicting principles put on the table by both sides. Indians held their argument on "equitable utilization" – the favourite of the International Law Association and took the position that Pakistan got 75% of the water represented violation of the principle of "equitable utilization". The Treaty came under heavy fire in the Indian Parliament and was subjected to trenchant criticism by most of the speakers who participated in the Lok Sabha debate on the subject on 30th November 1960. They blamed the Government of India for a policy of appeasement and surrender to Pakistan and said that Indian interest had been let down.From Pakistan side the fact that they were allocated only 75% of the water when they had 90% of the irrigated land represented a violation of the principle of "appreciable harm" – the favourite of International Law Commission.

Denial of perennial flows to Pakistan of three Eastern Rivers created tremendous management problems and resulted in the first "hydrological shock" whereby the vast and most productive irrigated land was deprived of perennial flows of river waters. The three rivers allocated to Pakistan under the Treaty were in the west whereas the irrigated land was in the east with hundreds of kilometers of distance between them. Pakistan not only had to undertake massive engineering works to transfer the water of western rivers to east through storage dams, inter-river link canals, barrages, headworks etc, construction of these infrastructural works were the largest civil engineering works ever undertaken in the history of the world and had to be completed within a record and challenging period of 10 years. Pakistan not only faced the problem of infrastructural development but had to set aside a large sum of money annually to meet the future operation and maintenance cost of these huge hydraulic structures exposing itself to a very high degree of structural safety hazards. The three eastern rivers allocated to India had a cumulative flows of 33 MAF out of which India was only utilizing 3 MAF and left with 30 MAF for future expansion. Against this Pakistan did not get any additional water and had to develop storages for its future requirements.

12.3 India's Bilateral Treaties with Nepal and Bangladesh

12.3.1 Treaties between India and Nepal[5]

Nepal and India so far have entered into three agreements on the construction of Joint Projects on three main rivers-Koshi, Gandaki and Mahakali. Among the three Projects first two are in operation while the third one on Mahakali River has not yet been started.

Both the Koshi River and the Gandak Project Agreements were widely criticized by Nepalese people, as such, they were subsequently amended. However, those amendments did not alter the substance of the agreement particularly the sharing of benefit between the two countries. They remained heavily imbalanced. As a matter of fact, these were the projects done in Nepalese soil by India for their own uses. Whatever meager benefit was given to Nepal was simply some fraction as a gesture. Till to date, in the mind of the general public there is ill feeling about India in Nepal due to these projects.

The third Agreement was signed in 1996 between India and Nepal on the Integrated Development of the Mahakali River. This agreement combines three different projects – the Sarada Barrage, the Tanakpur Barrage and the Pancheshwar Dam on the river. The Pancheshwar Dam Project is yet to be constructed. Among the three Projects, Pancheshwar is a Multipurpose Dam Project generating more than 6,000 MW of electricity and irrigating more than one million hectares of land in India and about 94,000 hectare of land in Nepal. The project benefits also include flood control. The project is to be constructed on the river Mahakali which forms border between the two countries. The Project Report has not been completed because of the differences between the countries on the calculation of benefits to India and its share in the cost. Although the agreement was concluded in 1996 Detail Project Report for Pancheshwar has not been completed. However, other components of the Agreement like Sarada Barrage and Tanakpur power house are in function and India is getting full benefits out of these projects. Nepal's benefits from these projects are meager. From delayed tactics, it looks as India does not want to construct the Pancheshwar Project. India is already getting almost the entire water of Mahakali River and using it through Sarada Barrage and Tanakpur power house the first of which was constructed under agreement and the second was unilaterally constructed by India on the face of Nepalese opposition. Apart from the above three projects both the countries are in negotiation on water resources for the last 30 years without much success.

12.3.2 Treaty between India and Bangladesh[6]

India constructed a barrage at Farakka on the upstream of the Ganges and started withdrawal of water on the basis of an ad-hoc agreement signed on 18 April 1975. In this agreement, Bangladesh gave consent for withdrawal of 11-16 thousands cusecs water from April 21 to May 31, for a limited period of 41 days. In return India promised that rest of the water will flow through Bangladesh. But after the expiry of 41 days period, India kept on withdrawing water in the lean period of 1975 and 1976. In April 1976, the flow of water at Hardinge point came as low as 23,000 cusecs against 65,000 cusecs of the corresponding time of previous years. India signed a 5-year water-sharing treaty with Bangladesh on 5 Nov 1977. The treaty had a Guarantee Clause for getting 80% of the flow during lean period and an arbitration clause. After the expiry of the Treaty in 1982, India refused to renew/extend the time period. However, on October 1982, a two-year mutual agreement followed by another three years agreement was signed between the two sides, but the Guarantee and Arbitration clause of 1977 Treaty were withdrawn. On 12 Dec 1996, a 30-year Water Treaty was signed between India and Bangladesh, which was also devoid of the Guarantee and Arbitration clauses. After the 1996 Treaty, during the lean period,

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[5]Surya Nath Upadhyay – Mahakali Treaty: The View from the Negotiating Table.

[6]Professor Dr. Jasim uddin Ahmad, Mostafa Kamal Majumder – Regional Cooperation for Sharing Transboundary River Water.

for the last few years, the flow of water at Hardinge bridge point comes down to 10,000 cusecs, even sometimes as low as 5,000 cusecs. The adverse impacts on the environment and ecology of Bangladesh are so heavy that the Farakka Barrage is popularly known in Bangladesh as "Death Barrage".

12.3.3 Inter-basin River Linking Project

India is now implementing a gigantic project, 'Inter-basin River Linking Project' to divert water from all the common rivers. This project has two components (i) the Himalayan component 14 link canals and (ii) the Peninsular component 16 link canals, all together 30 link canals will be excavated within the frame work of the project interlinking 37 rivers. The total length of these link canals would be finally47,000 km. The breadth of the link canals would be 50-100 meters and the depth 6 meters.

The upstream withdrawal of water through Farakka Barrage has already started desertification syndrome in Bangladesh, intrusion of salinity in the inland fresh water and created many serious environmental problems including the bio-diversity loss. In addition if India executes the inter basin river link project, then Bangladesh known all over the world as a land of rivers, fish and rice and a beautiful green land will lose all its present identity.The rivers included in the inter basin river link projects are all international or common rivers between India and Bangladesh. Therefore unilateral construction of any barrage on upstream, withdrawal of upstream water and change of river course are definitely in violation of the international laws.

12.4 India's latest policy document[7]

India's latest thinking on transboundary waters is amply reflected in a recent report by Institute of Defense Studies in India (IDSA 2010) on water security and elaborates the increasing attention to water issues within a broader geographical context. While reviewing India's bilateral water relations with neighboring countries, country by country, the report notes that if not managed well, riparian issues will lead to increased conflicts. It calls for a paradigm shift from the historical supply side considerations in domestic and international agreements, and past investments focused on water sharing among competing interests, to one that focuses on benefit-sharing. It stresses that rivers can no longer be viewed as a "soft-component" of a country's foreign policy. Rather they must be seen as intricately linked to development goals and domestic needs impacting bilateral relations. The report goes on to say that while it is important to adopt sensible riparian policies and 'healthy rivers' schemes, there is a need to re-evaluate existing treaties and reframe them based on current hydrological knowledge and future mutual needs. India's geographical contours place multiple upper, middle and lower riparian systems within its borders – thus placing it at the epicenters of riparian politics. Therefore, collaborative riparian management will be crucial for setting many of the water induced conflicts in the region; greater hydro-diplomacy both internally and across national borders – will need to balance the region's growing water needs with larger security concerns.

12.5 Evolution of International Water Laws

The International Water Laws since then have constantly gone under evolutions to reflect current understandings, which recently are more oriented towards the promotion of cooperation rather than conflict, encouraging interest-based prospects rather than positional discussions and negotiations. The primary role of the Law in this context is to enable determination of each state's equitable and

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[7] Institute of Defense Studies and Analysis (IDSA) (2010) Water Security for India: The External Dynamics, New Delhi: IDSA.

reasonable "entitlements" to the benefits of the use of Transboundary waters and to establish certain requirements for state's behavior while managing and developing the resource. To prove that benefit-sharing paradigm is really a good idea, it will become incumbent on the water resources management practitioners to demonstrate the material benefits and positive-sum outcomes to adhere to its principles. This is essential in creating confidence in the stake holders on both sides of the divide.

Commenting on International Water Laws and IDSA Task Force Report in the Oct-Nov 2010 publication of Dams, Rivers and People, New Delhi; the importance of role of water in the national and regional politics is summed up as **quote** "Resource nationalism will increasingly dominate the hydrological contours of South Asia and will largely define regional politics."

"The hydrological contours of India, both as an upper riparian and a low riparian, will be the epicenter of new riparian politics and diplomacy over transboundary rivers ……. India's riparian relations with its neighbors will become progressively fragile with Pakistan, Bangladesh and Nepal continuously raising concerns over regulating and sharing of river waters."

"International Water Laws on allocating water within river-basin are difficult to implement and often contradictory" **unquote**.

The UN Convention on Non-Navigational Uses of International Watercourses approved in 1997 by a vote of 104 to 3 (but not yet ratified) requires watercourse nations (Article 5) to participate in the use, development and protection of an international watercourse in an equitable and reasonable manner. Burundi, China and Turkey (upper riparians) voted against the Convention. India (middle riparian) abstained. While Bangladesh (lower riparian) voted for, Pakistan abstained. Of the other transboundary South Asian states, Nepal voted for and Bhutan was absent. The convention was adopted by a vote of 104 in favour to 3 against and with 27 absentees.

From India's acts and approaches it becomes quite obvious that India would not honour International Water Laws and would not respect the existing treaties. India in International Forums have repeatedly indicated that under water stress situation and climate change impacts the existing treaties would become irrelevant.

12.6 A way forward[8]

Moving forward with particular thinking or mind set can never see the end of the path. The complexities of issues, lack of political wisdom and will, positional based stands, high level of mistrust, linkages to Kashmir issue, negative public perceptions and deep buried hostilities offer formidable obstacles to cross. Any move forward will require a deep analysis of the mind sets on both sides. India's past history, its respect for already executed treaties and its recent thinking have to be taken into consideration. Whereas India suggests to adopt a paradigm shift from conflict to cooperation and from water sharing to benefit-sharing, its hegemony in declaring itself as at the epicenter of riparian politics due to its geographical contours tantamount to a warning to other riparian countries. India is suggesting to re-evaluate the existing treaties and reframe them on current hydrological knowledge and future mutual needs (IDSA 2010). Under these circumstances, the way forward is to honestly implement the existing treaty IWT 1960 in its true spirit.

12.6.1 Issue that can be addressed bilaterally

[8]John Briscoe. War or Peace on the Indus. The News International. April 03, 2010 and Sardar Muhammad Tariq, Regional Chair, Global Water Partnership – South Asia (GWP-SAS), Islamabad, Pakistan

i. To remove mistrust on data exchange, satellite based data collection system should be installed for real time data information. Cost of such system should be shared by both.

ii. Since storage for flushing sediments has already been allowed to India, its timing is crucial for Pakistan's agriculture. This should be addressed bilaterally and can be resolved amicably once real time data becomes available. Otherwise with multiple hydropower stations being constructed by India on the western rivers their cumulative storage can impose major reductions on water availability in Pakistan during the critical planting season.

iii. Since hydropower does not consume water, the only issue is timing, and timing is a crucial issue because agriculture in Pakistan depends not only on how much water comes but that it comes in critical periods during the planting season. Under normal and trustful relations India could increase low-flows during the critical planting season with significant benefits to Pakistan and small impacts on power generation in India.

iv. Presently there is a very uneven playing field. The regional hegemon is the upper riparian and has all cards in its hands. The Institute of Defence Studies in India has clearly and in unambiguous terms has identified India as the "epicenter of riparian politics". This asymmetry means that changes must start in India. India therefore would need to have some courageous and open minded Indians who realize and explain to the public why it is an essential and vital issue for Pakistan.

v. If there is goodwill, there are multiple ways in which the treaty could be maintained and interpreted so that both countries could win. Otherwise both countries would be dragged into unending processes of litigations. India looking for grey areas in the treaty and Pakistan on the offensive with development on both sides having negative impacts leading towards serious conflicts.

vi. Discussions on Indus Waters Treaty should be delinked from both historic grievances and from the other Kashmir related issues, both sides showing a sign of statesmanship, and moving forward considering water as catalyst for development and not a resource for conflicts.

vii. Climate change impacts: Various models indicate that global warming can accelerate glacier melt with the result that additional water would flow in rivers originating from Himalayan ranges. Since treaty stipulates average flow to be released to Pakistan, India can easily divert this additional water either for direct uses or filling up the large number of storage dams without letting Pakistan to benefit from this additional water. This issue could be taken up with India with positive suggestions to work out a joint climate change adaptation strategy in combating droughts and floods where water shortages and surpluses are jointly managed with minimum negative impacts on both countries.

Bilateral development of Kabul River: Similarly Pakistan and Afghanistan should also adopt a strategy in developing the water resources of Kabul River jointly and protecting Pakistan's historic rights on water uses. This is also a priority area where Pakistan must initiate dialogue with Afghan Regime as soon as possible.

12.6.2 Issues which can attract International support and understanding

i. ***Environmental flows to maintain river biodiversity:*** India, during low-flows, diverts almost 100% of the waters of three eastern rivers leaving vast stretches of rivers within Pakistan's boundary completely dry. This violates the International River laws where environmental flows and maintaining rivers health is mandatory for the riparian states. IUCN, WWF, GEF, UNEP,

UNDP and many other organizations are strong advocates of such issues. Pakistan can raise this issue with these organizations and in the international forums.

ii. ***Transboundary aquifers:*** Another emerging issue on water and benefit-sharing is the maintenance of Transboundary groundwater aquifer. India with low power tariff has encouraged installation of tube wells in Eastern Punjab and other bordering states with Pakistan with the result that ground water aquifers within Pakistan are over-mined by India. This issue can also be raised in the international forums with favourable reaction. International conference on Transboundary aquifers was held in Paris, France on 6-8 Dec 2010 organized by UNESCO and addressed in depth the issues of shared aquifers.

iii. ***Transboundary Water Pollution:*** The natural slopes facilitate the flow of untreated effluent from East Punjab to West Punjab. Under international water laws riparian states are required to ensure untreated effluent is not discharged into rivers, natural nullahs etc. This is again a justifiedand that Pakistan can raise in the international forums with favourable reactions. The four East Punjab drains a major issue.

12.7 Water Management Issues

A point to be noted is that good geopolitical management however, is only possible when countries successfully manage their myriad domestic water challenges. Currently complex national level issues of food, water and energy tend to be addressed in a cylindrical fashion by sector focused ministries when cross sectoral analysis and solutions are urgently needed. Pakistan therefore, needs to address its domestic water challenges seriously in an integrated and coordinated manner. Every drop of water needs to be utilized most judiciously to achieve more food, more value and more jobs. Pakistan needs to correct its direction on top priority basis in managing national waters, else its position on Transboundary negotiation will remain on weaker wicket. The dismal water management statistics such as 132 cubic meter per capita storage against America's 6,150 m^3, Australia's 5,000 m^3; carry over capacity of only 30 days as against 1000 days of Egypt; Contribution of 34 cents by one cubic meter of water to the GDP against developed countries of US$ 30 to 40 and wasting precious water resources to the tune of 1334 billion cubic meter value at US$ 158 billion into sea over the last 32 years makes Pakistan's case extremely difficult for securing any international support. Pakistan is also one of the few countries in the world which does not have a National Water Policy. Pakistan's total hydro power potential is close to 100,000 MW. Pakistan has developed only 6500 MW i.e. 6% only. As against this India has constructed 4,700 medium to large dams and created a carry over capacity of 220 days. India's productivity is three time more than Pakistan and a unit of water contributes about US dollar 4 to Indian GDP. Total hydro power potential of India is 148,700 MW out of which India has already developed 31,000 MW and over 50 hydro projects are under different stages of development. India's share of coal in the overall energy production is 69% whereas Pakistan's share is only 1% in spite of having one of the largest coal deposits in the world. India plans to create additional 180 BCM of storage volume by constructing some 2,500 dams by the year 2050. Pakistan therefore needs to have a paradigm shift in its overall water management strategy.

Both countries are managing their water resources in dismal manner. Water has strong linkages with food, energy, poverty and environment. With vast agricultural lands, four distinct climates, enough sunshine and demographically young man-power can revolutionize their economies by changing their mind-sets from water conflicts to water as catalyst for regional cooperation and development.

12.8 Pakistan's Perspective

- Water sharing formula recommended by the World Bank and accepted by Pakistan was not the best.
- Pakistan got 75% of the Indus Waters against 90% of the irrigated land – according to International Law Commission it tantamount to violation of the principle of "Appreciable harm".
- The IWT divides the rivers of the Basin – with three eastern rivers given to India, Pakistan loses the lower riparian rights.
- Maintaining the river health and biodiversity, the minimum environmental flow is being denied.
- Prior to IWT, India was utilizing only 3 MAF of eastern rivers flows but got 33 MAF under the Treaty.
- Whereas India got 30 MAF additional water for future development, Pakistan got nil.
- India has multiple basins for inter-basin transfer opportunities, Pakistan was depending on single basin with no additional water.
- Pakistan considers the historic uses allowed to India on the western rivers restricted to small interventions of local communities living along the river banks and not constructing mega hydropower projects and putting them on national grids.

12.9 Issues and Challenges Crated by IWT for Pakistan

- Irrigated area in the east and water in the west.
- Over 8 million acres of most productive land of Pakistan in West Punjab denied water of the three eastern rivers.
- Pakistan was compelled to undertake world largest civil engineering works to transfer water through canals, headworks and barrages from western rivers to irrigated land in the east.
- The hydraulic infrastructure development under the Treaty resulted in huge O&M challenges and heavy O&M annual cost.
- Infrastructure resulted in high degree of safety hazards under exceptional floods.
- Sediments flourishing delta were trapped in canals and headworks resulting in millions of coastal belt becoming non-productive with severe salt intrusion.
- Thousands of villages in the coastal region had to be abandoned.
- The Treaty resulted in denial of environmental flows in the three eastern rivers as they enter Pakistan badly affecting river health and biodiversity.
- The inter-river canal network resulted in twin menace of water logging and salinity.
- With 33 MAF of eastern rivers water given to India, the per capita availability of water declined sharply in Pakistan.

12.10 Challenges created by the Treaty for Pakistan

- Transfer of water over hundreds of km through new structures.
- Huge O&M challenges with heavy O&M annual cost.

- High degree of structural safety hazard – heavy floods.
- Sediment flourishing delta were trapped.
- Resulted in twin menace of water-logging and salinity.
- Single basin constraints.
- With three rivers given to India, water availability per capita declined considerably.

12.11 India's Hegemon Role in the Region

12.11.1 Treaties with Nepal

- Koshi River Agreement 1955
- Gandaki River Agreement 1959
- Mahakali River Joint Development Agreement 1996

12.11.2 Nepal's Complaints

- Projects under the agreements are heavily imbalanced with most of the benefits in terms of irrigation water , hydropower, flood control are going to India
- Projects located on Nepali soil but benefit going to India
- Heavy resentment among Nepali people
- Negotiations from last 30 years with no results
- India keeps on re-interpreting the treaty clauses to its advantage
- Treaty could have formed a good example of benefit-sharing had India stuck to original clauses.

12.11.3 Treaties with Bangladesh

- Agreement on Farakka Barrage – 1975.
- This agreement guaranteed certain minimum amount of water – India flouted this agreement.
- India signed another 5-year agreement in 1997 guaranteeing 80% of flow during lean period but refused to extend it beyond 1982.
- India signed 2-year agreement in 1982, followed by 3-year agreement in 1985 and a 30-year treaty in 1996.
- In all these agreements/treaties India refused to include guarantee and arbitration clauses.
- Due to excessive withdrawal by India at Farakka Barrage rivers in the Padma Basin in Bangladesh have turned into dead rivers.
- 300,000 acres of land has been affected.
- A vast area of land once a granary of Bangladesh has become desert and a food-deficient area

- During flood season India suddenly opens up all gates at Farakka Barrage flooding large part of Bangladesh
- During lean flow periods, India diverts water for its own uses with the result wells in Bangladesh dry up enhancing sea-water intrusion and spreading salinity.
- Post Farakka Barrage arsenic contents have appeared in the ground water and desertification started in the north-west part
- India's "Inter-Basin River Linking Project" diverting flows of transboundary rivers would further deny water to Bangladesh.

12.12 India's Latest Policy Document

The gist of policy document produced by Institute of Defense Studies in India (IDSA 2010):

- If not well managed riparian issues would lead to more conflicts
- Calls for paradigm shift from water-sharing to benefit-sharing
- Rivers are no more "soft component of country's foreign policy
- Treaties need to be evaluated and reframed based on current hydrological knowledge and future mutual needs
- Document places India at the epicenter of riparian politics due to its geographic contours
- It suggests collaborative riparian management for setting many water induced conflicts
- It emphasizes greater hydro-diplomacy to balance regions growing water needs with larger security concerns

12.13 Evolutions of International Water laws

- Under constant evolutions – promotion of cooperation rather than conflict – emerging interest-based prospects rather than positional discussions.
- Law to help determine state's equitable and reasonable entitlements.
- Establish certain requirements for state's behavior while managing and developing the water resources.
- UN Convention on Non-Navigational uses of International Water Courses approved in 1997 by a vote of 104 to 3 (not yet ratified). India abstained and Pakistan followed the suite.

12.14 Institute for Defence Studies and Analyses (IDSA) Stand

- International water laws on allocating water within river basin are difficult to implement and often contradictory.
- India considers that under water stress situation and climate change impacts, the existing treaties would become irrelevant.

12.15 Five Constituencies in India with Different Views

- First Constituency – In favour of Indus II under Article VII & XII of the IWT for a joint development of the Indus Water Basin.
- Second Constituency – Favours a new Indus Treaty considering IWT as partitioning Treaty – Indus II to focus on new hydrological relationship.
- Third Constituency – Pressure group in Indian Kashmir asking for unhindered use of the Indus, Jhelum and Chenab rivers.
- Fourth Constituency – War over water not an option. India should use water as coercive tool and bargaining instrument for larger politico-strategic objectives of India.
- Fifth Constituency – India should exploit all potentials permissible under the Treaty first and then ask for more and ask for review of the Treaty.

12.16 Transboundary Water Issues – International and National

- India should allow minimum flows in the eastern rivers to maintain rivers health in Pakistan.
- Transboundary aquifers – presently India is over mining the transboundary aquifers affecting groundwater in Pakistan. Joint monitoring mechanism should be established.
- Transboundary Water Pollution: India should check untreated effluent entering Pakistan.
- India under a planned programme, helping Afghanistan to build dams on Kabul River.
- India is also encouraging Afghanistan to raise objections on Pakistan's proposed dams on Indus River such as Bhasha, Dasu, etc.
- Within Pakistan, provinces interpret some clauses of 1991 Interprovincial Water Apportionment Accord for their respective benefits creating contentious issues.

13. ENERGY CRISIS AND THE DEADLY POLITICS OF WATER

Suleman Najib Khan

Preamble: Ever wondered why strategic planning is trashed periodically in Pakistan? Why the nation's hydro endowment & its related national assets are suffering attrition & neglect? India's water war is no longer surreptitious. It is now a blatant, cold-blooded campaign. Her transparent interference internally in Pakistan has created an anti-dam lobby within the three smaller provinces. Their open opposition to a second reservoir on the Indus after commissioning of Tarbela Dam (1974) has been disastrous for Pakistan's economy. Kalabagh Dam (KBD) is recognized in all the major studies as a +100 years reservoir at the point of maximum flow of the Indus Main. Punjab, Pakistan's largest populated province and breadbasket has seen its agricultural output stagnate. No thanks to Pakistan's rising population the per-capita agricultural output has fallen in real terms. Poverty & the resulting tensions within the Federation have multiplied. India's internal factor (in Pakistan) & external activities (in Kashmir) have inflicted upto 2013 a financial loss of over a trillion USD equivalent to the PAK economy. Potentially the richest nation of South Asia is now a basket case. Due to Pakistan's failure to build multi-purpose dams (after 1974) the desired hydel:thermal ratio has become lopsided; around 30:70. Imported oil based power generation can never be sustainable without the hydel energy mix.The financial deficit has climbed above USD 10bn for the first time. The national debt servicing is even greater. Cotton textiles its dominant agro based sector has not grown in real terms. KBD project the 2nd dam on the Indus Main stands blocked under a grand conspiracy. Refer Chapters1, 8 &14.

India now goes ahead with plans to build 100 + hydro-electric projects on Pakistan's waters flowing through Indian Held-Kashmir; the so-called three western rivers: Indus, Jhelum & Chenab. She uses a benign concession in the landmark Indus Waters Treaty of Sep 1960 to justify building dozens of high dams & creating reservoirs in cascade. India also lays claims on the waters that Pakistan's anti-dam lobby compels it to waste. Pakistan is already since several years facing the inexplicable scenario of drastically shrinking inflows from her western rivers. An economic suffocation orchestrated by its upper riparian neighbor. Indian maneuvering & high handed tactics leading to the IWT 1960 got them the entire flow of the three Eastern Rivers. Pakistan leadership accepted to receive and maintain the East Punjab drains; Hudiara, Kasur Nala, Salimshah & Fazilka under Art IV of IWT-60. It was an unprecedented & anti-civil milestone in modern history. Today, Pakistan's second largest city Lahore is sinking in sewage. Its life sustaining Ravi river has become a sewer. It's deep water pumps throwing up arsenic & nitrates far beyond safe limits. Irrigation water situation in South Punjab is now critical. The anti-dam lobby has ensured reduction of Pakistan's storage capacity to about 8% of its annual surface flows. Clean drinking water had already become a nationwide struggle.

Pakistan is choking economically due to its water stressed situation. Yet the Indians project themselves as the aggrieved party. The 2010 floods have demonstrated that due to lack of mega dams the rivers delivered an additional +40MAF into the sea. Nature's gift became a destructive force due to the missing reservoirs. I focus on the lack of large reservoirs especially KBD & the ignored hydel energy potential. The tragic mistakes clearly orchestrated by our regional adversary & the deadly fifth column within the republic.

13.1 Why Pakistan's economy could not become self-sustaining (a primer)

We were by 2006 heavily dependent on oil based IPPs and the developing "Circular Debt" has been growing menacingly since 1996 due to an unsustainable Imported Energy Policy. The era of massive deficit financing & de-industrialization had arrived. The nation had been trapped in the guise of FDI. How could the thermal based privatization policy lead to lower tariffs? Tragically we had created a USD two billion financial black hole in our economy by the year 2004 due to the uncapped private thermal

generation; based on imported oil. The Independent Power Producers (IPPs) were inducted under the 1994 Power Policy. The devil is in the detail. Today this financial black hole has at least doubled because RFO/HFO (& Diesel fuel) for power generation had crossed +14 million tons/annum. Our hydel development has been dismal and the mega reservoir projects are virtually on hold since Tarbela Dam (1974). The surface storage is now less than 8% of the average 145MAF surface flows. In 2008 & again in 2009 Mr. Shakil Durrani, Chairman WAPDA a non-technical bureaucrat advised the Federal Minister to announce the official closure of the Kalabagh Dam project (KBD/KDP) and WAPDA House was the venue for this tragic announcement. Does a nation, a town, a village, a home require "consensus" for its sweet water supplies. Multi-purpose reservoirs are the lowest cost electric energy source besides providing irrigation water, flood control & aquifer recharge.

One had been aware of the basic recommendations of the TASK FORCE on Energy (Jan 94). The serious concern was that any policy based on imported energy, which is uncapped, will destabilize WAPDA therefore the national economy and eventually damage the Federation. The World Bank had estimated USD 0.8 mn/MW but later allowed USD 1.2mn/MW. It is universally accepted that any IPP controlling +10% of the power supply is a monopoly. In this period Bangladesh was purchasing steam power stations with gas fired boilers at USD 350,000/MW. Later 15 of the 19 originally sanctioned IPPs under the '94 Private Power Policy were established. Together with the freshly inducted IPP's & a privatized KESC the nation will generate about 130bn electrical units in 2014 limited only by the financial & infrastructural constraints manifesting itself as the so-called "Circular Debt". About 75% of the total thermal installed capacity & more than 50% of Pakistan's generating capacity is in private hands. Presently a Pakistan owned industrial group is managing HUBCO and we are confident that they will improve its energy mix. Water based HPPs were not favoured by IPPs due to longer gestation. This must change as the energy mix of 70:30 hydel:thermal is a national goal

Both China and India never appreciated this IMF/World Bank concept. When the GNP of a nation does not rise in tandem with its GDP (due to excessive outflows of profits and dividends) we have economic and social upheaval. The British Imperial masters had increased India's GDP. Eventually they had become a liability. Secondly we all know that economic inequities lead to political & social cataclysms. Historically FDI has often been misdirected and used as a tool of exploitation. The nation has to eliminate the mindset (the syndrome) that led to the 1707-1857 debacles for Muslims in India. A culture of scientific thought must be implanted.

13.1.1 Proposed KBD & future floods:

On 09 Feb 98 a premier conference on Water Reservoirs in the National Economy was held at Islamabad. All major aspects of our predominantly irrigated agriculture, hydel potential & related aspects were addressed. Eminent speakers had discussed the benefits of reservoir construction and explained the details of the IBIS (Indus Basin Irrigation System). The expected pit-falls in the building of Diamer Bhasha Dam (DBD) & the near impossible status of Katzarah / Yago / Skardu on humanitarian & ecological grounds were also deliberated by several experts. A resolution was unanimously approved for the construction of at least one reservoir on the Indus without further loss of time. Everyone agreed in Feb 1998 that 10 years after Tarbela commissioning a new reservoir's construction should have started and could have been available by 1990. Forty years since Tarbela the situation is doubly critical.

Delay in KBD construction is a staggering wastage of around USD 230bn equivalent between 1990 and 2010. A second reservoir on the Indus capable of +6MAF storage which would have compensated for the depletion of PAK reservoirs since the commissioning of Warsak, Mangla, Tarbela & Chashma & could have kept our economic growth far ahead of our population increase. Only KBD met the criteria for a quick & cheap replacement reservoir to offset the storage capacity lost. A near hopeless sociological situation as seen today would have been averted. The floods of July/Aug 2010 have shown that KBD would have complemented Tarbela Dam's intrinsic flood attenuation & mitigation capabilities. The construction of proposed Munda Storage project on The Swat River would also have been helpful for flood control. The 1.2MAF storage at Munda so close to the population centers is capable of

providing around 1.5Bn units/year. The Munda - KBD conjunctive operation presents a wonderful opportunity for inter-provincial cooperation. The energy output of KBD could increase by around 250GWh (0.25Bn units) at average head of 200 ft, due to Munda Dam. Flood attenuation a major bonus.This report presents a sustainable version of The Great Indus Cascade (2015 – 2040) in Chapter 14.

13.1.2 DBD cannot replace KBD:

After the April 2006 ground-breaking ceremony of Diamer Basha Dam (DBD) we observed a stalemate. General Pervez Musharraf was trying to look good inline with his announcement of Jan 2006 that Pakistan will build six large dams by 2016. I refer to the attached three letters of 2004 written by late Dr. Ghulam Safdar Butt (Lt. Gen Retd) to General Pervez Musharraf. Now Dr. Butt was heavily critical of the dam's height proposed by lead consultant M/s Nespak - MWH/Harza & others known as the NEAC consultants JV. He was equally critical that the 281m Roller Compacted Concrete (RCC) design would have an unprecedented crest level at +3900 ft. asl. The possibility of 8MAF (10 cubic km) breaking loose; is a potential "hydro bomb" of 10bn tons hanging over the nation. Construction of the world's highest light structure RCC dam instead of an Arch-Gravity structure (with a earth/rock core) in the region of severe seismic history was playing with fire . The NEAC JV however had chosen an economical site location. The cost was estimated at USD 6.45bn including downstream upgrading as well as upstream relocation of the KKH & environmental mitigation. The likes of Senator Nisar Memon and his "Indus Forum" had prevailed upon General Musharraf to enlarge the Diamer Basha Dam so that KBD goes into the background. The Chapter 14 gives the 1987 height comparison of KBD & DBD viz 260ft & 660ft. DBD was mischievously proposed in 2004 as a 920ft high structure implying that KBD now stands assimilated into DBD. The height was as a result of Dr. Butt's intervention decreased but only by a few meters. Dr. Butt's visit to WAPDA House accompanied by three of us, on 30 June 04, was a direct result of Dr. Butt's first letter of 02 June 04 to Gen. Musharraf. Refer Chapter 15. It was a fascinating face-off in WAPDA House.

Senator Nisar Memon had announced the Technical Committee (on Large Dams) in 2003. The eight member committee was to be led by Mr. A.N.G. Abbasi whose anti KBD views were universally known. In presence of the Water Accord of March 1991 the attempts by the anti-dam lobby to quash the KBD project is simply high treason. Senator Nisar Memon's technical committee of 2003 finally decided that DBD can be built while KBD if built maybe just a carryover dam devoid of any irrigation canals. Very unfair to KP.

Immediately after attending the 30 June 04 meeting at WAPDA House Dr. Butt decided to write a hard hitting letter to Chairman WAPDA Mr. Tariq Hameed. I quote a few lines from Dr. Butt's letter "This is a dangerous area to build a dam. The prosperity and survival of the country depends on this and other dams. Geology of the area has not been fully studied. Jaglot syncline is a highly active tectonic element. Basha is located within its stress field where tectonic movements are permanently going on. Frequency of heavy earthquake is considerable. Their epicenters are not too far. More detailed & precise investigations are necessary. Recent 2002 earthquakes in Nanga Parbet Massif (NPM) can initiate several landslides. If that happens after the dam is built & a wave is generated that may fail the dam & spill over it. The downstream devastation to Tarbela and all other barrages, upto Kotri would be enormous. I shudder at the thought". On 08 Oct 2005 Dr. Butt's apprehensions based on his thirty years pioneering work on the KKH were proven correct. University of Peshawar's paper from 2002 (Authors Mohammad Riaz & Ghazanfar Khattak) is a must read on earthquake / seismology of the Nanga Parbet area with particular reference to DBD. The paper also covers "reservoir induced earthquakes" as a very real phenomenon & classified as triggered or induced earthquakes. The Sichuan earthquake of 12 May 2008 is a tragic example.

The detailed Feasibility Studies of August 2004 by the NEAC JV had been ignored and the new consultants (Lahmeyer JV)had selected a wider site 2km downstream. The width/volume of the dam structure nearly doubled. The cost also increased to around +USD 12bn with additional cost for KKH up

gradation from Thakot to site. DBD site area offers no construction inputs, locally. The explanation for this drastic change being the location of a steep granite embankment on the left bank of the NEAC JV site location. Till today we have understood that granite embankments are desirable but the Lahmeyer led JV of Design Consultants went ahead with this disastrously expensive site change. In-house adviser Dr. Izhar, a retired WAPDA engineer succumbed to the pressure of the Lahmeyer JV. Lahmeyer was also deeply involved in Baglihar-I& other IHK projects. The terribly expensive site change is due to consideration of tariff / Royalty sharing between GB province & KP province. It is a national shame. The Royalty formula as proposed to the Federal Ministry in 2006 by the venerable Shams-ul-MulkLocation of the power house in his report is a minor royalty factor (he proposed 15%). Another national tragedy was being enacted and the people of Pakistan were kept ignorant. One power house would have been more feasible. Enough funds could be saved to build KBD within 5 years as well; in the same costs as the Lahmeyer JV designed DBD. We have lost the opportunity to construct the narrow DBD as per earlier NEAC JV feasibility but we can still build a lower DBD within 7 years (instead of 10 years) at less than half cost of the Lahmeyer JV design. **Will the Indian lobby allow the reversal?**DBD must be built as a smaller, safer dam whose reservoir would also be a sediment/debris trap for a part of the 200mn tons sediments that will pass DBD . DBD height be reduced and instead of a high RCC structure covered by a plastic membrane, it must be a CFRD (Concrete Faced Rockfill Dam). Life extension of Tarbela Dam is critical. DBD in cascade allows incremental energy at Tarbela of +1,450GWh (1.45Bn units/year) due to higher winter flows of the Indus river.

WAPDA Chairman Mr. Durrani had continued to conceal the Greater Kashmir card of India. They effectively lobbied with the multilaterals that the Northern Areas are part of Greater Kashmir. She has blocked World Bank financing for Pak mega projects such as Diamer Basha Dam & Bunji HPP due to this linkage. There can be no peace until the Indians abandon their hydro offensive in all its manifestations.Kashmir as declared by the Quaid is our "jugular vein".

Lower the dam height to 200m above river bed as per demand of seismic realities. Have one power house, if still feasible. Save funds & build KBD within 5 years as well in the same costs as the Lahmeyer JV designed DBD. It will be possible to construct the DBD lower and safer within 7 years (instead of 10 years). Will the Indian lobby in Pakistan allow the reversal? DBD must be built as a smaller, safer dam whose reservoir would also be a sediment & debris trap for a part of the +160mn tons that reaches the Tarbela reservoir every year. Life extension of Tarbela Dam is very desirable. The Dasu HPP, Pattan HPP and Thakot HPP will receive regulated flow due to the upstream DBD and debris free waters which will enhance their operational lives atleast ten fold. DBD will allow incremental energy at Tarbela of atleast 1,450GWh (1.45Bn units/year). DBD must not become a source of seismic initiation & catastrophic flooding in the words of Dr. Butt. Not only DBD height be reduced but instead of a high RCC structure covered by plastic membrane, it must be a CFRD (Concrete Faced Rockfill Dam).

13.1.3 Akhori:

Off-channel storage is a revolutionary idea, which needs to be studied. It is not a replacement for the KBD but one day it could supplement the Tarbela reservoir. There is negligible power generation at Akhori. It is not an alternate to KBD. If WAPDA will build T-5 then Akhori will be a non-starter.

13.2 The Hydel: Thermal ratio a key to economic independence

Labeling Northern areas as "Greater Kashmir" because the ruler in Srinagar a century ago exerted influence in Baltistan is like saying that Peshawar, Kohat & Kabul are parts of Greater Punjab because Ranjit Singh once held away over these Western towns. Gangster Logic! Why are we allowing the fifth column to conceal these deadly realities? While we address this menace and compel the government of the day to reject this "Greater Kashmir" theory we may rethink our national strategy for a sincere Fast-Track hydel development.

Let us assume that reservoirs on major rivers are presently not being allowed by pro-Indian political elements & their bureaucrat nominees. At best in the next three years we can expect about 2,000MW run-of-river projects to be commissioned providing around 5bn units per annum. Over 85,000MW firm hydel potential is waiting to be utilized. Pakistan is one of the nine countries that could utilize hydropower for +50% of its entire energy needs well into the 21st century.

13.3 Indian hydro policy in IHK & Pakistan's NJHPP

Tragically the Indians are now guilty of laying the groundwork for genocide of our nation through the ongoing theft of Pakistan waters. India is in the process of planning & constructing +171 hydroelectric power projects (HPP) in Indian Held Kashmir (IHK). Atleast 42 projects on the three western rivers and their tributaries are already in operation. Atleast 14 are under construction & remaining 115 in advanced stages of planning & design. Indian official strategy is to achieve +28,000MW installed hydroelectric capacity in IHK before 2020. This fact has been known since many years. The technical parameters of two large projects (1500MW Sawalkot Dam HPP & 1000MW PakalDul HPP) on the Chenab within IHK are available.

There are 17 projects in operation on Chenab & its tributaries. Three more are under construction (including Baglihar II). Another 56 are in advanced stages of planning & design. The IHK projects in operation on Chenab main include Salal Dam & HPP (345MW) as well as Baglihar I HPP (450MW). The Salal Dam for example has considerable storage capability which can be mis-operated in violation of the Indus Waters Treaty (1960) and could seriously affect the inflow into Pakistan (at Maralla). Secondly on Jhelum & its tributaries another 13 projects are in operation, 8 projects under construction & 43 HPP in advanced planning stages. Work on their Wullar Barrage Project was suspended; the URI HPP (480MW) is operating. Pakistan should have reacted in 1996 when the first Indian memo announcing the Kishenganga HPP project. The IWT 1960 does permit transfers between Jhelum tributaries in IHK but it is a violation of the IWT 1960 when it interrupts natural flow required for the downstream Neelum Jhelum HPP in AJK.Completion of Pakistan's Neelum Jhelum HPP (NJHPP) should have meant that India cannot operate its Kishenganga HPP. Pakistan has the rights to the uninterrupted use of the western rivers. Any other interpretation is diabolical& contradictory. There was no race between the two parties. On the Indus & its tributaries 12 smaller projects are operating, 3 under construction. Refer to Chapter 1 for details on IHK Projects.

It is apparent that by constructing these HPP in cascade, creating substantial storage at any given time, Indian would seriously disturb the flow (and timing of the flow) of the western rivers in clear violation of the IWT 1960. Such activity would have serious repercussion on Pakistan's future reservoir projects such as KBD & HPP projects on the Jhelum river including NJHPP. The depleted flow in the Neelum due to the Kishenganga HPP diversion means NJHPP cannot produce 5,000GWh from its 969MW powerhouse. It is clearly becoming the world's most expensive HPP.

Conclusion: With pondage from dozens of HPP projects in IHK the cumulative gross storage at any moment of time will be several MAF & inherently lethal for all downstream infrastructure projects and the Indus Basin Irrigation System (IBIS). Pakistan has priority and exclusive rights (with minor exceptions) over the waters of the Western rivers and this issue is non-negotiable. Pakistan's anxiety to secure these rights had resulted in the historic blunder within the IWT 1960; of granting India the 100% water rights of the three eastern rivers (Ravi, Sutlej, Beas). India has to be made to respect Pakistan's exclusive rights on the Western rivers. Dr. Hon. Shams ul Mulk has advised that it is now the eleventh hour to establish Pakistan Water Rights on the Western Rivers. Pakistan must go to the International Commission for justice and ask for the dams to be demolished. All the dams & structures built by India in IHK are in violation of the IWT 1960. "No dam is without storage", he advises his countrymen.

Drowning without water

Tribune_031212

Primer - 12

We can play politics... or we can build dams

It is a crisis in the making that will dwarf the current power scenario

A KHURRAM BAIG
KARACHI

Research has shown that by the year 2025 about 35% of the world's population will live in countries affected by water stress or water scarcity. It has also been proven, based on research that while Pakistan was at one time a water-sufficient country, now it is a water-deficient country. This is of special significance because our water resources are contracting, and our water needs are above the global average because of the agrarian nature of our economy.

It is also significant that unlike a lot of developed economies, we are still a young and also a growing population so water needs are expected to grow exponentially in the coming years.

It is an irony that Pakistan either has floods or droughts. In such a situation it is of primary importance that in all other spheres of life, policies based on water conservation as well as strategies where the water table can be maintained at optimum levels should be the focus of the government.

I know what I am going to say next will probably make most people cringe. We need to build the Kalabagh Dam. We need to build lots of dams, but we also need to build the Kalabagh Dam and our political leadership needs to show some maturity, and get it done.

We have no choice

So what are the issues with the Kalabagh Dam that make it such a pariah that even the mere mention of the name raises political and nationalist hackles? It is probably not the

> We need to build lots of dams, but we also need to build the Kalabagh Dam and our political leadership needs to show some maturity, and get it done

fact that the dam is capable of irrigating six to seven million acres of land. It surely can't be the fact that the dam can irrigate about 800,000 acres of land that is at a higher altitude than the river Indus. And the fact that the dam will also help produce about 3,800 megawatts of cheap hydropower has got to be a huge selling point. But apparently it is not enough.

For a country that is agrarian in nature – an industry that is the most water-intensive of them all – it does not seem to be important enough. For a country that is looking at a looming food security issue, it does not seem important enough. For a country that suffers from severe floods and droughts, it does not seem to be important. For a country that is facing the worst ever power crisis, it does not seem to be important enough. But it should be. The consequences of believing otherwise can be catastrophic.

Bashir A Malik, former chief technical adviser of the United Nations and World Bank, has said and this has been reported in the press that, "Sindh and Khyber-Pakhtunkhwa will become drought areas in the years to come, if the Kalabagh Dam is not built." At the same time former K-P chief minister Shamsul Mulk has said that the "Kalabagh Dam will help in erasing poverty from Khyber-Pakhtunkhwa, as it will irrigate 800,000 acres of cultivable land that is located 100-150 feet above the level of River Indus." And Diamer-Bhasha Dam is not a substitute for Kalabagh Dam because of its limited irrigation capabilities, because of the terrain.

I won't even go into the flood control options that the dam will offer with its ability to store almost seven million acre feet of water.

One of the arguments that India has often used is that Pakistan does not use the water it has, either for hydropower or for irrigation, and therefore India should not be stopped from doing so. This has helped it win World Bank funding for many projects, even though they are being built on disputed territory.

The opposition

Sindh and K-P are the major opponents of the dam, and they both have a number of concerns. Some of these concerns are frivolous and political in nature. Others are not. Some concerns that

> There are issues, some real, some concocted, but the government, at the federal and provincial level can find a work-around in the national interest

Sindh has are that it will see a decreased flow in the river Indus and that it will see a reduced water pressure from upstream that it needs on its coast to avoid an incursion by the sea. Sindh also fears that the once powerful river Indus, already a shadow of its former greatness will become no more than a stream with yet another mega dam. These are concerns that can, and should be addressed. But Sindh's concern that its share of the Indus water will be curtailed as water from the Kalabagh will go to irrigate farmlands in Punjab and Khyber Pakhtunkhwa, at their cost is simple political propaganda. This can be discussed and a mutually agreeable water-sharing formula can be evolved, if the political will exists.

K-P fears that like the Ghazi-Barotha project which is located in K-P, but the power generation turbines were built in Punjab, Kalabagh Dam may see a similar scenario. This has given Punjab the right to royalties from power generated from Ghazi Barotha even though it has said it will claim no royalties. But what is more significant for K-P is that it has denied it the option of claiming those royalties. This can be worked out so that it does not happen again.

Political will

There are issues, some real, some concocted, but the government, at the federal and provincial level can find a work-around in the national interest, and all parties involved should keep that in mind, the greater national interest.

Primary requirement of food requires copious amounts of water. More than two thirds of all freshwater abstraction worldwide (and up to 90% in some countries) goes towards food production. This is also something we need to think about in the years to come.

We need to put all our energies behind speeding up the pace of work on this and also the Diamer Bhasha Dam. We need to resolve our issues with India and move faster with the Neelum-Jhelum Dam. And all relevant bodies that are related to the development and regulation of water resources in the country like the Water and Power Development Authority and the Indus River System Authority (Irsa) and others need to do their jobs. And our political leaders need to let them!

14. FLOODS AND A HELPLESS NATION. GLOBAL WARMING SCENARIO (Appended note: the Impact of Sea Level Rise)

Suleman Najib Khan

14.1 Floods 2010.The rationale for large dams. What is WAPDA upto?

14.1.1 Preamble:

Floods such as the apocalyptic one in 2010 can also be made into a net gain for the economy. Assuming we had a storage of around 30 to 40MAF instead of the depleted 11MAF storage available in 2010(the high being 17MAF in 1974) the flood peaks would have been attenuated and generally contained. Overflow of banks in the plains of Punjab & Sindh would have been manageable. Above all a bounty of sweet water stored for the economic growth of the people. Every MAF wasted is a +USD 2Bn loss to the economy. An unforgiveable sin for a nation that boasts the world's largest contiguous manmade irrigation system (IBIS) at its disposal.

14.1.2 Proposed KBD & floods:

Tarbela clearly moderated the floods of main Indus stem by 250,000 cusecs thus not allowing the flow at Jinnah Barrage to exceed one million cusecs; a flow that would have been catastrophic for all barrages downstream including the creaky Sukkur Barrage. Major reservoirs have three purposes viz, Irrigation Water, Electrical Energy & Attenuation of Floods. Nowshera was seriously affected by flood in Kabul River. Kabul River is a major tributary of River Indus which joins it about 4km above Attock gorge. It starts from Chitral, flows to Afghanistan and again enters into Pakistan near Warsak passing through Peshawar & Nowshera valleys. It merges with Swat River upstream of Nowshera before joining the Indus, downstream of Nowshera city. The heavy rainfall in end July 2010 created the excessive flash flows in Chitral, Swat, Panjkora, Kalpani rivers etc (all tributaries of the Kabul). The flood measurement gauges of WAPDA were drowned and washed away at its Nowshera flow gauging station. Flows at Nowshera were about 250,000 c/s on 29 July 2010. The river later peaked at about 400,000 c/s. Unprecedented rains in Tarbela catchment near Pattan, Gilgit and Gupis created exceptionally high flow conditions at Tarbela (840,000 c/s) resulting in outflow of around 605,000 c/s on 30 July 10. This in combination with outflow of 400,000 c/s from River Kabul & 70,000 c/s of Kalpani River should result in 1,075,000 c/s flow at Khairabad but due to Attock Gorge backwater affect it was 995,000 c/s. If KBD had existed with the reservoir level initially at about 820ft & if the irrigation requirements had been met also at Chashma Barrage (downstream of KBD) it would have achieved its maximum conservation level of 915ft around early August 2010 when outflow at Tarbela was around 390,000 c/s & Kabul River + Kalpani around 120,000 c/s. Cumulative flow at Attock Gorge would have been about 510,000 c/s. KBD would have kept its outflow at a range of 240,000 to 600,000 c/s and maximum level of reservoir would have been about 878ft. If required KBD could have allowed a maximum discharge/outflow of 1,200,000 c/s. Compare this with the maximum floods of 995,000 c/s reaching Khairabad on 30 July 2010. How a backwater situation could have been created due to the existence of the proposed KBD reservoir? The WAPDA Management played politics.

Is it not a tragedy that Chairman WAPDA & his Member Water continued to harp on their deadly hypothesis that if KBD had existed the flood damage would have been greater!? The real cause of flooding at Nowshera and Peshawar valleys upstream are; entrance of Kabul River at Nowshera into a confined channel (gorge) at the end of the wide Peshawar valley and backwater affect of Attock Gorge downstream through which Indus River has to pass after its confluence with Kabul River. Indus River

flows through a wide valley of over 8,000ft and is then forced to pass a 1,000ft wide gorge for about 8kms. This constriction forces the river water to backup thus giving rise to flood levels in Kabul River. Flooding of Nowshera city is due to one gorge at Nowshera & a second at downstream Attock. Proposed KBD site about 160km downstream of Attock with a live storage capacity of 6.1MAF & max conservation level 915ft (asl) will act (similar to Tarbela) as a downstream flood mitigator. KBD is indeed ideally located to regulate rainwater below the Potohar plateau and the best storage for flood control. Please note the appended study which negates,infact trashes, this irrational position.

The floods of July/Aug 2010 have shown that KBD would have complemented Tarbela Dam's intrinsic flood attenuation & mitigation capabilities. The construction of proposed Munda Storage project on The Swat River would also have been helpful for flood control. The 1.2MAF storage at Munda so close to the population centers is capable of providing around 1.5Bn units/year. The Munda - KBD conjunctive operation presents a wonderful opportunity for inter-provincial cooperation. The energy output of KBD could increase by around 250GWh (0.25Bn units) at average head of 200 ft, due to Munda Dam.

14.2 Global warming predictions

Great Floods are predicted. Grain Output worldwide will fall.Worldwide over 6 Bn tons of CO2 is emitted every year into the atmosphere. The greenhouse effect caused by an invisible blanket has resulted in an average 0.7oC rise. Glacier melt has increased exponentially around the world since 50 years. The Polar caps began to shrink dramatically. Pakistan's sweet water supply is +70% fed by the mighty glaciers. Without several new reservoirs we are not prepared for extra-ordinary flooding &non-seasonal flows expected over the next 25/30 years. Sweet water once lost by the glaciers is not recoverable. As a result of this modern menace nearly 50% of glacier retreat has already occurred (around 33% loss of surface area). Switzerland tried to cover the alpine glaciers with plastic fabric unsuccessfully.

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Appendix :A virtual study to determine any hydrological impact of proposed KBD on floods 2010.

KALABAGH DAM (KBD) AND ITS AFFECT ON NOWSHERA DURING FLOOD, 2010

Proposed KBD site is located at about 160 kms downstream Attock. Live storage capacity of the dam is 6.1 MAF and maximum conservation level is 915 ft. The truth is evident from:

Reservoir Operation Projected

Scenario-I: Release according to Indents.

Flood Routing has been carried out for floods 2010. On 29 July, 2010 the reservoir level was 825 ft. Keeping in view the irrigation requirement (IRSA Indent) 241,000 cusecs (requirement at Chashma) will be released and storing the remaining inflow in the dam. The reservoir will attain its maximum conservation legel 915 ft, on 7th August 2010. On 7th August the outflow from Tarbela was 392,000 cusecs whereas flow of Kabul was 121,000 cusecs. The total cumulative inflow at Attock becomes 513,000 cuescs (Table-2).

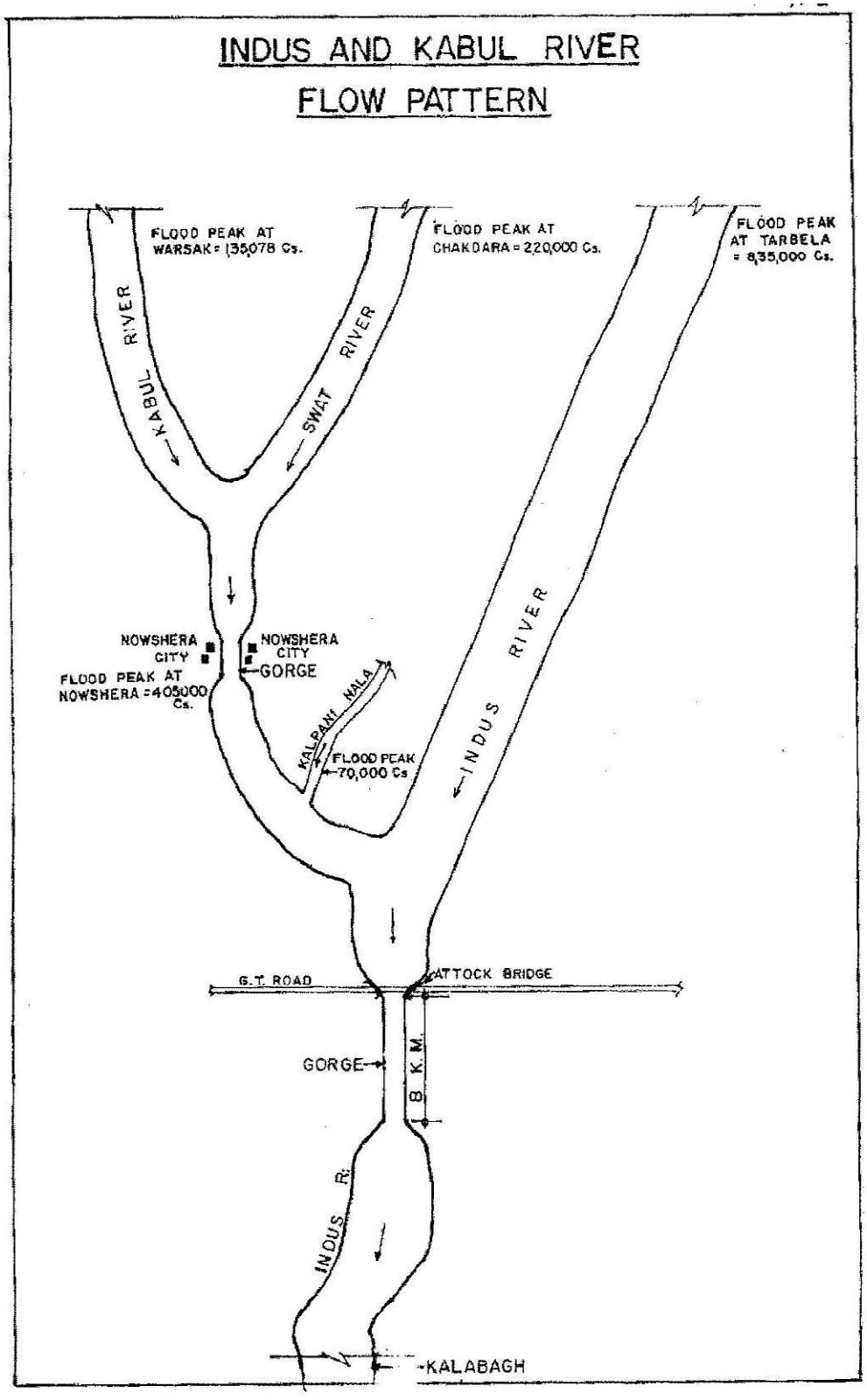
Scenario-II: Flood Mitigation.

In this case the dam is operated with slowly increasing outflows from 241,000 cusecs to 600,000 cusecs. In this case maximum level of reservoir will only rainse upto 875 ft. on 03 August 2010. Later on itwill start decreasing (Table-3).

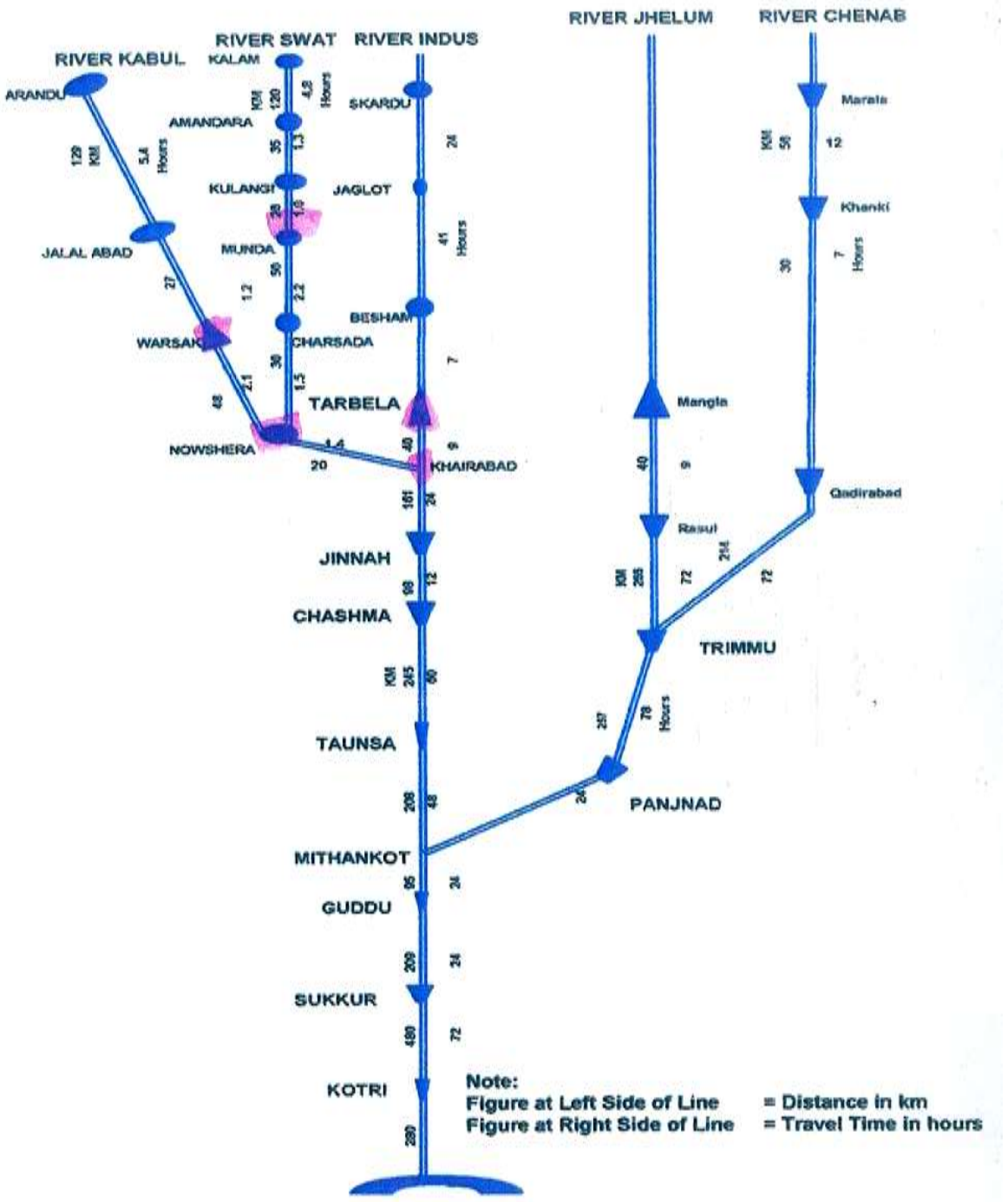
Scenario-III:

Outflow capacity of Kalabagh is 1,200,000 cusecs whereas maximum flood peak at Kalabagh was 997,000 cusecs during flood 2010. When all outlets of dam are opened then there is no change of back water effects.

Even in scenario-II level of dam will not rise above 875 ft. So back was situation will not occur. KBD has absolutely no connection with floods in Nowshera area of KP.


INDUS AND KABUL RIVER
FLOW PATTERN
FLOOD PEAK AT WARSAK = 135078 Cs.
FLOOD PEAK AT CHAKDARA = 220,000 Cs.
FLOOD PEAK AT TARBELA = 835,000 Cs.
KABUL RIVER
SWAT RIVER
INDUS RIVER
NOWSHERA CITY
NOWSHERA CITY
GORGE
FLOOD PEAK AT NOWSHERA = 405000 Cs.
KALPANI NALA
FLOOD PEAK 70,000 Cs
G.T. ROAD
ATTOCK BRIDGE
GORGE
8 K.M.
INDUS R.
KALABAGH

FLOOD WAVE TRAVEL TIME



DISCHARGES DURING FLOOD 2010 (CUSECS)

At Tarbela, Warsak, Chakdara, Nowshera and Khairabad

From 26-07-2010 to 29-08-2010

DATE/TIME	TARBELA RESERVOIR OUTFLOW	KABUL INFLOW AT WARSAK	SWAT RIVER AT CHAKDARA	KABUL INFLOW AT NOWSHERA	INDUS RIVER AT KHAIRABAD
26-JUL/ 600	210000	41242		53300	259800
1200	211900			50900	258500
1800	214400		23516	52400	260500
2400	215800			53800	266500
27-JUL/ 600	219500	41191		53200	262500
1200	223900			53300	274700
1800	228800		24946	58800	288400
2400	120900			60600	299700
28-JUL/ 600	115800	57190		61000	200000
1200	390700			61000	158400
1800	409800		25758	90600	352100
2400	422500			138600	528400
29-JUL/ 600	439100	107439		187455	590300
1200	466500		**220000**	243100	652200
1800	528600		Station	296000	737200
2400	580400		damage due	350500	854700
0500	**604000**		to flood		
30-JUL/ 600	603000	**135078**		**405000**	942000
1200	479000			391250	979500
1500					**997300**
1800	485400			377500	977000
2400	488400			363750	966500
31-JUL/ 600	476000	98880		350000	956000
1200	464600			331250	923100
1800	411600			312500	899000
2400	395600			293750	864900
1-AUG/ 600	357000	64181		275000	750200
1200	358400			247500	750200
1800	359800			220000	705000
2400	381300			192500	663100
2-AUG/ 600	327000	51801		165000	604900
1200	339700			158750	583600
1800	340700			152500	565500
2400	329400			146250	535800
3-AUG/ 600	317500	58941		140000	481900
1200	318600			137500	444400
1800	319900			135000	435300
2400	320700			132500	446500
4-AUG/ 600	318600	55997		130000	462000
1200	322300			127500	455600
1800	322300			125000	446500
2400	323400			122500	488600
5-AUG/ 600	324200	66771		120000	452100
1200	324600			114500	426300
1800	338600			115800	434600
2400	365800			115800	429800
6-AUG/ 600	366400	68750		114000	446500
1200	376300			117800	476900
1800	391400			124200	494900
2400	418400			122700	504300

DISCHARGES DURING FLOOD 2010 (CUSECS)

At Tarbela, Warsak, Chakdara, Nowshera and Khairabad

From 26-07-2010 to 29-08-2010

DATE/TIME	TARBELA RESERVOIR OUTFLOW	KABUL INFLOW AT WARSAK	SWAT RIVER AT CHAKDARA	KABUL INFLOW AT NOWSHERA	INDUS RIVER AT KHAIRABAD
7-AUG/ 600	407700	68536		123400	535100
1200	432200			151200	568500
1800	433100			172700	629500
2400	436600			189000	663100
8-AUG/ 600	436100	9832		205700	689900
1200	455300			213500	687500
1800	492700			221400	705000
2400	493900			226900	716300
9-AUG/ 600	490000	108754		231600	722700
1200	511800			232900	727500
1800	537100			236600	729100
2400	538500			243100	755100
10-AUG/ 600	539300	95483		248800	761600
1200	516600			249100	767400
1800	517000			242200	759200
2400	476900			231200	750000
11-AUG/ 600	453500	87660		222600	730800
1200	455000			215800	701900
1800	480900			212900	690700
2400	434700			209800	686000
12-AUG/ 600	389400	74683		207600	682800
1200	389300			190500	674100
1800	391200			174100	645100
2400	429900			165400	610300
13-AUG/ 600	418500	71320		156100	567000
1200	404000			152900	604900
1800	380400			164700	601900
2400	355000			164000	585100
14-AUG/ 600	299600	66267		162200	568500
1200	342000			153000	502100
1800	357800			150400	480500
2400	370000			147600	483400
15-AUG/ 600	371000	64641		144900	497800
1200	364700			138200	507900
1800	371300			136400	510100
2400	356700			133900	513300
16-AUG/ 600	342000	62931		134000	508700
1200	342300			127200	467700
1800	357300			126700	469800
2400	354600			121700	469100
17-AUG/ 600	334800	59190		116500	466200
1200	334600			112400	458500
1800	335000			113700	446500
2400	322700			107900	442300
18-AUG/ 600	287600	56744		103100	438800
1200	304400			98700	398900
1800	328500			100200	386800
2400	336500			95100	407100
19-AUG/ 600	336500	51369	23180	90800	433900
1200	311900			91000	424900

DISCHARGES DURING FLOOD 2010 (CUSECS)

At Tarbela, Warsak, Chakdara, Nowshera and Khairabad

From 26-07-2010 to 29-08-2010

DATE/TIME	TARBELA RESERVOIR OUTFLOW	KABUL INFLOW AT WARSAK	SWAT RIVER AT CHAKDARA	KABUL INFLOW AT NOWSHERA	INDUS RIVER AT KHAIRABAD
1800	313300			93900	405000
2400	314900			93700	412500
20-AUG/ 600	347500	46581	23520	90300	418700
1200	298300			89100	419400
1800	307200			93900	436700
2400	291000			96300	416700
21-AUG/ 600	291400	46747	23040	92000	410200
1200	292000			81900	382700
1800	308700			85000	378000
2400	283900			86300	394800
22-AUG/ 600	259600	45473		81900	386800
1200	293300			77400	365400
1800	276600			81000	367400
2400	276800			80000	377400
23-AUG/ 600	212900	45190		76000	369400
1200	294200			73800	352900
1800	294300			76400	354800
2400	311300			77400	378000
24-AUG/ 600	312100	42555		74000	382000
1200	310800			72900	406400
1800	245000			75900	400300
2400	268800			75800	402300
25-AUG/ 600	268900	45637		75700	343800
1200	268600			73300	342500
1800	269300			77600	351000
2400	269100			83300	356900
26-AUG/ 600	261000	48744		89100	351600
1200	260600			84400	350300
1800	261000			76900	340600
2400	235900			70200	336700
27-AUG/ 600	211300	39181		68000	319300
1200	210300			66500	270800
1800	211200			68300	259400
2400	210400			64600	257000
28-AUG/ 600	178600	33524		61200	256400
1200	177300			59500	208800
1800	178000			56100	212100
2400	170700			54100	223000
29-AUG/ 600	170200	28319		53000	208200
1200	169400			50700	197600
1800	169400			48100	192100
2400	169700			50500	198700
30-AUG/ 600	169600	26351		47500	194700

TABLE- 2

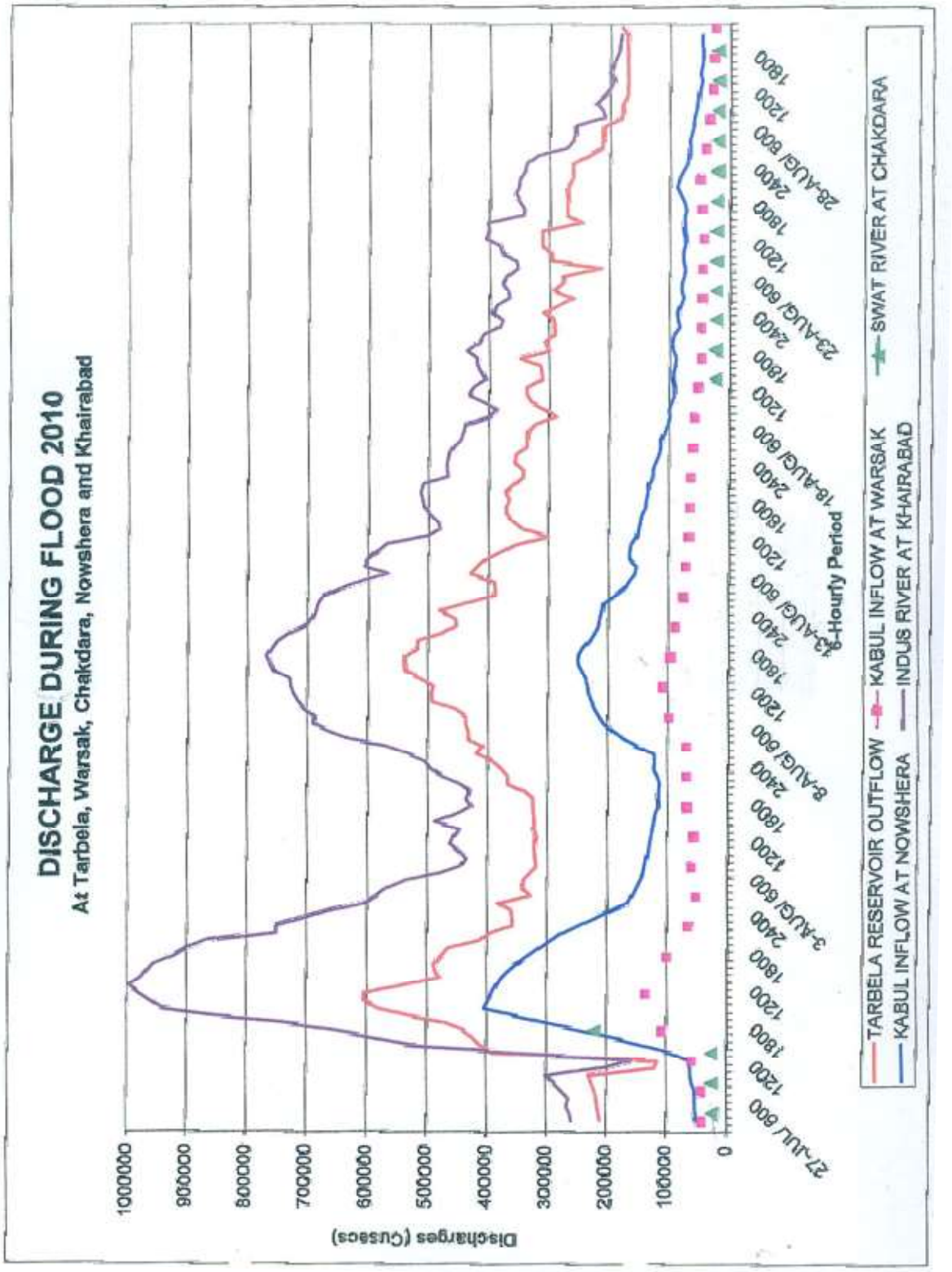
KALABAGH DAM Reservoir Operation During Flood 2010

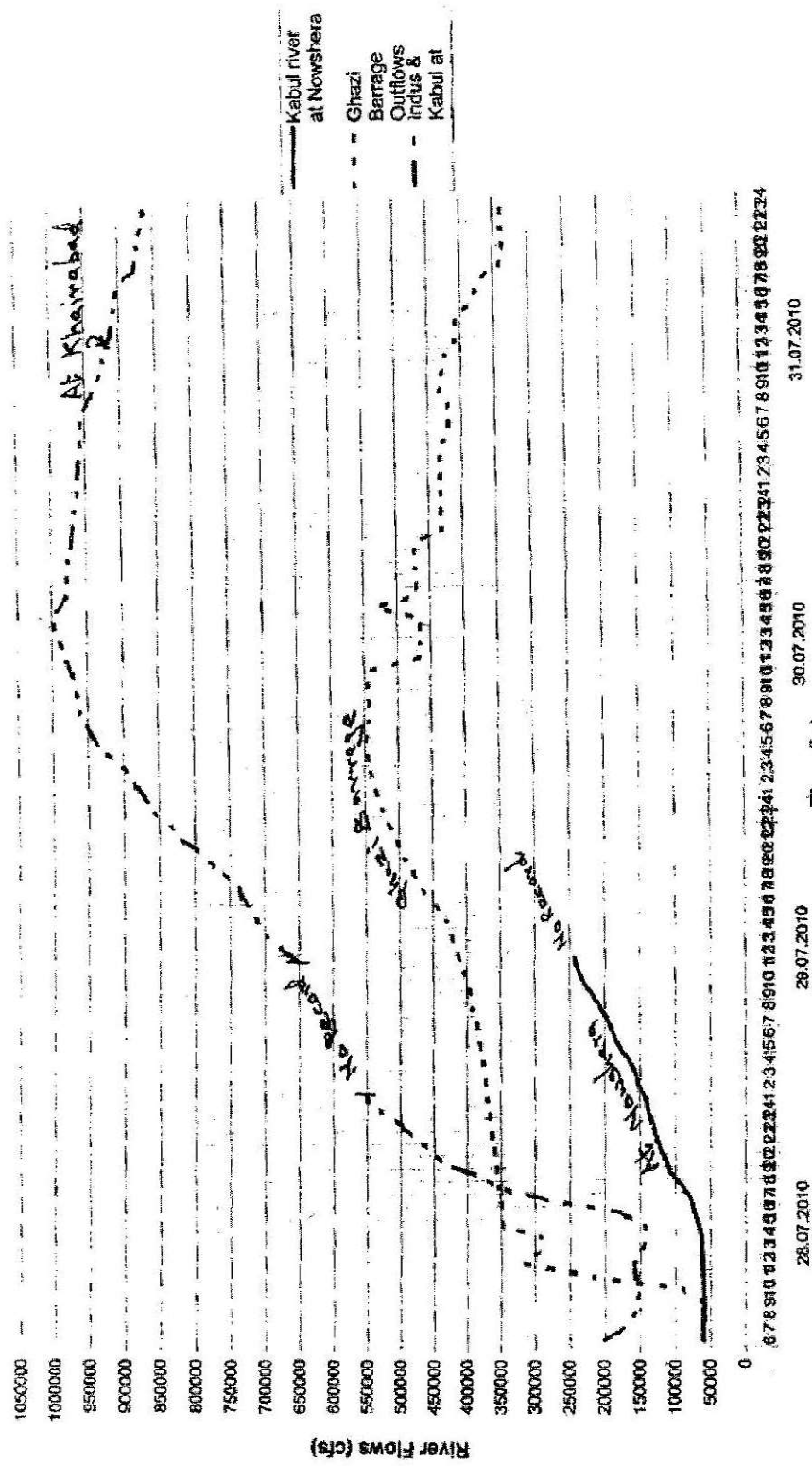
July & Aug. 2010.	Kalabagh Inflow	Indent / Outflows	Storage		Accumulated Capacity	RESERVOIR LEVEL (Ft.)
	Cusecs		Cusecs	MAF	MAF	
29	412416	241000	171416	0.340		825.00
30	686479	241000	445479	0.884	0.340	833.84
31	824256	241000	583256	1.157	1.224	854.78
1-Aug	777558	241000	536558	1.064	2.381	875.27
2	737403	241000	496403	0.985	3.445	887.92
3	517683	241000	276683	0.549	4.430	899.62
4	474591	241000	233591	0.463	4.979	904.67
5	443291	241000	202291	0.401	5.442	908.86
6	422855	293000	129855	0.258	5.843	912.51
7	472438	472438	0	0	6.101	915.00
8	559151	559151	0	0	6.101	915.00
9	595022	595022	0	0	6.101	915.00
10	624500	624500	0	0	6.101	915.00
11	658501	658501	0	0	6.101	915.00
12	621298	621298	0	0	6.101	915.00
13	579758	579758	0	0	6.101	915.00
14	535511	535511	0	0	6.101	915.00
15	472836	472836	0	0	6.101	915.00
16	487352	487352	0	0	6.101	915.00
17	449318	449318	0	0	6.101	915.00
18	430944	430944	0	0	6.101	915.00

TABLE- 3

KALABAGH DAM Reservoir Operation During Flood 2010

July & Aug. 2010.	Kalabagh Inflow	Outflows	Storage		Accumulated Capacity	RESERVOIR LEVEL (Ft.)
	Cusecs		Cusecs	MAF	MAF	
29-Jul	412416	241000	171416	0.340	---	825.00
30	686479	350000	336479	0.667	0.340	833.94
31	824256	450000	374256	0.742	1.007	851.02
1-Aug	777558	550000	227558	0.451	1.750	864.27
2	737403	600000	137403	0.273	2.201	872.32
3	517683	600000	-82317	-0.163	2.474	876.46
4	474591	600000	-125409	-0.249	2.310	874.29
5	443291	600000	-156709	-0.311	2.062	869.86
6	422855	600000	-177145	-0.351	1.751	864.30
7	472438	600000	-127562	-0.253	1.399	858.02
8	559151	600000	-40849	-0.081	1.146	853.50
9	595022	600000	-4978	-0.010	1.065	852.05
10	624500	600000	24500	0.049	1.055	851.88


DISCHARGE DURING FLOOD 2010
At Tarbela, Warsak, Chakdara, Nowshera and Khairabad
Discharges (Cusecs)
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
27-JUL/ 600
1200
1800
2400
28-AUG/ 600
1200
1800
2400
23-AUG/ 600
1200
1800
2400
18-AUG/ 600
1200
1800
2400
13-AUG/ 600
1200
1800
2400
8-AUG/ 600
1200
1800
2400
3-AUG/ 600
1200
1800
2400
Hourly Period
TARBELA RESERVOIR OUTFLOW
KABUL INFLOW AT WARSAK
SWAT RIVER AT CHAKDARA
KABUL INFLOW AT NOWSHERA
INDUS RIVER AT KHAIRABAD


Indus River Flood Hydrograph 2010
Kabul river at Nowshera
Ghazi Barrage Outflows
Indus & Kabul at
River Flows (cfs)
Time (hr)
28.07.2010
29.07.2010
30.07.2010
31.07.2010

Appendix

IMPACT OF SEA LEVEL RISE ON PAKISTAN'S COASTAL ZONES-CLIMATE CHANGE SCENARIO*(extracts from an article of National Institute of Oceanography, Karachi)*

Abstract: Pakistan has over 10% of its population living in the vicinity of the coastal zone, over 20 % of coastal area of Pakistan is relatively developed, 40% of industry is situated on or near the coast. Protecting these human assets will be costly, particularly if the effects of climate change are sudden rather than gradual. A rise sea level of a few mm per year, although not threatening but direct and indirect impact of this rise would have a profound impact on the coastal resources for sustainable coastal zone management. Direct land loss of low-lying areas can rapidly damage or destroy coastal ecosystems. In addition to sea level change a rise in global warming will also increase the frequency of tropical cyclones and will further add to the miseries of the coastal states. Pakistan's coastline with the Arabian Sea stretches to over 990 km. It comprises two distinct units in physiographic outline and geological characteristics. The coastal and offshore geology of Pakistan tectonically exhibits both active and passive margin features.The impacts of the hazards resulting from progressive climate change are apparent all along the coast. The adverse effect of sea level rise on the Pakistan coast is expected to be pronounced in the Indus Delta. Topographically it is a tidal flat zone. A sea level rise of about 2 metres is expected to submerge or sea encroach an area of about 7,500 sq km in the Indus Delta. The low-lying areas along the Baluchistan coast may also exert a significant effect. The mean sea level (MSL) along the coast at Pasni is about 1.4 m from the chart datum. The MSL is slowly but gradually rising at a rate of about 1.1 mm/year. Although a small sea level rise may be compensated by tectonic uplift rate of the Makran coastline estimated at 1-2 mm/year at Ormara.

Sea level rise on the coast of Pakistan: The existing information and data on SLR in the archives of the National Institute of Oceanography, Karachi, concurs with the world average rate of increase in sea level. The rate of sea level rise in Pakistan coastal region has been tabulated to approximate 1.1 mm per year. The effects of changes in regional climate is being seriously felt since the past two decades.

Currently scientific sea level information and data in Pakistan is insufficient to reconstruct any quantitative change. It would be pertinent to use eustatic sea level increase of 2 mm/year and 6 mm/year in order to predict possible scenarios for the Pakistan coast for the next 50 and 100 years. These are used as best estimates for sea level rise assuming "business as usual" worldwide emissions. The available Sea level data recorded in Karachi for the past 100 years has been tabulated. The correspondence in their increasing trends, may appear trivial but it clearly suggest, that global warming has had a significant effects on the sea level rise since the 1900. At Karachi the rate of 1.1 mm/year in sea level rise has been observed (Figure 1). Three scenarios- including the existing rate of 1.1 mm/year are shown in table 1. More important than the actual rise in sea level is the possible increase in the frequency and severity of storm surges, which combined with sea level rise, could result in devastating floods in the region. This sea level increase will cause stronger wave action, higher tidal amplitude and greater possibility of surge occurrence that will have significant socio-economic effects on the coastal regions. The combined consequential effects of these coastal processes have been observed in many parts of the Balochistan and Sindh coast. The coastal lowlands around the coastal areas are particularly vulnerable to further change in sea level rise and related coastal processes.

Table.1: Sea Level Scenarios

Rate of rise	After 50 years	After 100 years
1.1 mm/year	5.5 cm	11 cm
2.0 mm/year	10 cm	20 cm
6.0 mm/year	30 cm	60 cm

Prior to assessing the impacts of projected rise in sea level and the associated climate change, it is essential to understand the general characteristics of Pakistan's marine and coastal areas and the active dynamical physical processes.

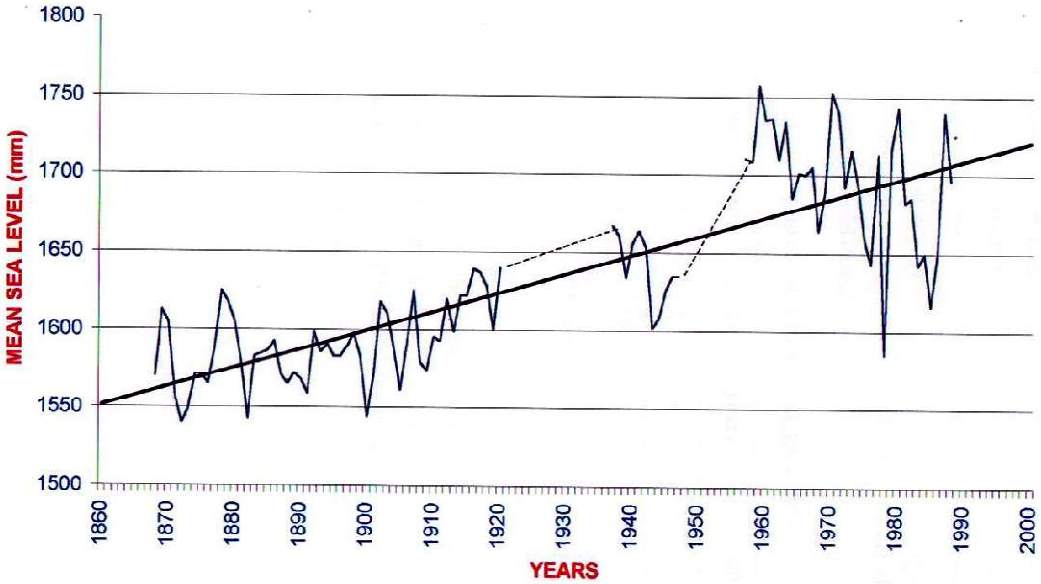


Figure 1: Trend of the Sea level Rise at Karachi. The present 1.1mm/year rate could increase quite rapidly due to land subsidence in the deltaic area as well as due to the predicted trend as given in Table 1.

Pakistan's coastline with the Arabian Sea stretches to over 990 km. It comprises two distinct units in physiographic outline and geological characteristics. The coastal and offshore geology of Pakistan tectonically exhibits both active and passive margin features. The Balochistan coast is active whereas the Sindh coast and Indus deltaic area and offshore Indus basin is geologically passive. The Sindh and Balochistan coasts have differing climatic conditions, geographical location and socio-economic factors.

Sindh Coast: The Sindh coastal region is located between the Indian border along Sir Creek on the east to Hub River on the west (320 km). The Indus River drains into the entire lower plain of Sindh. The Indus delta is the most prominent feature of the Sindh coast. The sediments are subjected to coastal dynamic processes, such as tides, winds, waves and currents, leading to accretion and erosion of the Indus deltaic coast. The coastal morphology is characterized by a network of tidal creeks and a number of small islands with sparse mangrove vegetation, mud banks, swamps and lagoons formed as a result of changes in river courses. The present delta covers an area of about 60,000 hectares and is characterized by 16 major creeks and innumerable minor creeks, mud flats and fringing mangroves. The delta supports wetlands rich in nature and culture, and also nurtures the largest area of arid climate mangroves. This area is very arid; receiving an average annual rainfall about 200 mm. 27% of this land is under water in the form of creeks and water courses. These water courses intervene the island, these are calm and protected water, and are flushed daily by tides ranging upto 3 m.

Karachi Coast: The coast of Karachi is situated between the Cape Monze, a high cliff projecting into the Arabian Sea and the Korangi creek. The coastline of Karachi metropolitan is about 70 km long. It is generally oriented NW-SE. On the western side it is bounded by the Hub river and on the east by the mangrove swamps and creeks of the Port Qasim area. The Layari and Malir river are the seasonal streams which flows during SW monsoon. The rain water from Karachi and its adjoining area drains in the Arabian Sea. The prominent feature of Karachi coast is shallow lagoons, raised beaches, marine terraces and dune fields. Four major inlets, Manora Channel (Karachi harbour), Korangi creek, Phitti creek, and Khuddi creek inveginate the coastline. A small crescent shaped sand bar exists at the mouth of the Korangi creek. The shore terraces and sea cliffs are due west of Hawks bay area. The Cape Monze beach is an example of raised beaches along the coast of Karachi. The eastern coast has tidal creeks with mangrove and mud flats. In the region the seabed is generally smooth.

The Indus Deltaic Coast: The present Indus delta is located at the head of the Arabian Sea, between Korangi Creek and the Runn of Kutch. The Indus drains into the northeastern Arabian Sea forming a large delta. The river discharges nutrient rich sediment load that has a great influence on the marine life of the Indus Delta and the near shore areas. The Indus delta has been found changing its fluvial characteristics due to damming upstream, which has reduced river borne sediments. This has resulted in drying up of the creeks and has induced sea encroachment further inland.

Balochistan Coast: The Balochistan coast extends from the mouth of the Hub River in the east to the middle of Gwatar Bay in the west and stretches over a distance of about 670 km. The Baluchistan coast has almost entirely desert like condition. The entire coastal area is arid with only 150-mm/year of rainfall. The coast is drained by the small rivers Hingol, Basol, Shadi Khor and Dasht. Despite having large catchment areas, these rivers flow only during the rainy season. Flash floods are frequent and even during scanty rains,there is erosion of top soil from the uncovered hillsides and muddy banks. The eroded material is deposited along the coast at the mouth of the rivers. The Baluchistan coastal region has cliffs, occasionally with rocky headlands, and a number of sandy beaches with shifting sand dunes. The region of creeks and coastal lagoon is marshy with scanty mangrove patches.

Appendix: River Basins of India. Classification under CWC Basin.

The entire country has been divided into 22 basins as per Central Water Commission.The names of the basins along with their id and area are given in the table.

Sr. #	Basin Code	Basin Name	Area(sq.km)
1	B1	Indus (Up to border)	321289
2	B2a	Ganga	861452
3	B2b	Brahmaputra	194413
4	B2c	Barak and others	41723
5	B3	Godavari	312812
6	B4	Krishna	258948
7	B5	Cauvery	81155
8	B6	Pennar	55213
9	B7	East flowing rivers between Mahanadi and Pennar	86643
10	B8	East flowing rivers between Pennar and Kanyakumari	100139
11	B9	Mahanadi	141589
12	B10	Brahmani and Baitarni	51822
13	B11	Subernarekha	29196
14	B12	Sabarmati	21674
15	B13	Mahi	34842
16	B14	West flowing rivers of Kutch and Saurashtra including Luni	321851
17	B15	Narmada	98796
18	B16	Tapi	65145
19	B17	West flowing rivers from Tapi to Tadri	55940
20	B18	West flowing rivers from Tadri to Kanyakumari	56177
21	B19	Area of inland drainage in Rajasthan	
22	B20	Minor rivers draining into Myanmar & Bangladesh	36202

Introduction of River Basin in India:
River basin is considered as the basic hydrological unit for planning and development of water resources. There are 12 major river basins with catchment area of 20000 km^2 and above. The total catchment area of these rivers is 25.3 lakh km^2. The major river basin is the Ganga-Brahmaputra-Meghna , which is the largest with catchment area of about 11.0 lakh km^2 (more than 43% of the catchment area of all the major rivers in the country). The other major river basins with catchment area more than 1.0 lakh km^2 are Indus, Mahanadi, Godavari and Krishna. There are 46 medium river basins with catchment area between 2000 and 20000 km^2. The total catchment area of medium river basins is about 2.5 lakh km^2. All major river basins and many medium river basins are inter-state in nature which cover about 81% of the geographical area of the country.**There are five classifications.**

15. THREE LETTERS OF LT. GEN. (R) DR. BUTT TO President MUSHARRAF.ONE TO WAPDA'S CHAIRMAN

Three unedited letters written by Dr. Butt to President Musharraf in 2004.One hard letter written to WAPDA Chairman, Mr. Tariq Hameed within a few hours of our delegation's visit.

15.1 Three letters of Lt. Gen (R) Dr. G. S. Butt to Gen. (R) Musharraf (2004)

Lt Gen G S Butt

10-A,TECH Society, New Campus,
Lahore-54590,Pakistan.

2nd June 2004

General Pervez Musharaf,
President of Pakistan,
ISLAMABAD

You are soon going to decide on the next dam to be built. My loyalty demands, that being a senior engineer, I express my views to you.

Please scan the next three pages. I have deliberately avoided talking about Basha located in seismic zone. I was involved in Pattan earthquake – repair of KKH and relief to the affectees. I shudder at the thought of earthquake effects on Basha. Dam-burst would wipe out Tarbela and all barrages on Indus; which would put us back to stone-age.

I have also talked to the Chairman WAPDA about these issues. I do not agree with their consultants, who would make their money and walk away, leaving the problem in our lap, like they did to us in case of Tarbela.

Fond regards.

Yours very Sincerely,

Lt. Gen. G.S. BUTT (R)

Copy forwarded:

1. Chairman WAPDA, WAPDA House, Lahore
2. Mr. Wasim Khan.
3. Mr. Suleman Najib Khan,
4. Mr. Mazhar Ali

Amongst a host of national issues with which you must be preoccupied, I hope you would have time to read this letter about construction of next dam on the River Indus. I am writing this letter to you based upon my extensive experience as an engineer in the Northern Areas working on the Karakoram Highway and subsequently as Chairman, WAPDA. Since then, as you would be aware, I have tried to remain in touch with the engineering profession, purely as an interested professional, and have interacted widely with many engineers associated with projects on the Indus and its tributary rivers.

The engineers working on Basha Dam have almost completed their feasibility level studies on behalf of WAPDA and have concluded that a dam 920 feet high above bedrock, costing nearly 6.5 billion dollars, could yield an annual live storage of over 7 Million Acre Feet (MAF) and generate 4,500 Mega Watts (MW) of hydroelectricity, commencing year 2015. Their reports and conclusions arrived at are prima facie quite impressive, **yet an in-depth study would negate the rosy picture as presented.** The ensuing paragraphs contain some of my considered views on the subject for your kind information.

1. **The upgradation of Karakoram Highway (KKH) from Thakot to Basha (approximately 200 km)** is a pre-requisite to the start of construction of the dam since heavy construction equipment and materials such as cement, pozzolons, steel and fabricated parts including huge turbines and generators etc. are to be transported to the site requiring greater road width, more gradual curves on turns and gentler road gradients. **In broadening the road width, as an example, almost vertical hillside slopes and highly weathered, jointed and fractured rock will have to be excavated right upto the mountain tops involving several thousand feet high cut along hundreds of km of length.** At places, shotcreting and rock bolting would be absolutely necessary to stabilize the excavated faces. All this activity has to be carried out while maintaining normal traffic. Based upon my personal experience on KKH, I can say with some confidence that this work is going to be on the critical path of the construction schedule **requiring as many as four to five years as opposed to two years currently provided for by the planners.** The cost of KKH upgradation will also be several times the amount estimated by the study team. I am not troubled, to the same extent, by the proposed additional work involved on some 100 km of existing KKH that will get permanently submerged in the Basha Reservoir and will have to be rebuilt at higher elevations, for the reason that this activity can continue in a careful but organized manner concurrently with the dam construction over a much longer period.

Submergence will take place only after the completion of the dam when reservoir impounding would start.

2. **The long, tortuous and highly expensive power transmission line,** carrying electricity back to the Indus Valley, is another superlative undertaking including its subsequent maintenance for all times to come. The engineers have **chosen a very high voltage of 765 KV (current maximum in Pakistan is 500 KV while that in India is 220 KV),** to reduce power losses on way, yet the problem is that the **"Switchgear" equipment for 765 KV is not available anywhere in the world.** The planners are recommending an alternative of 500 KV in case Pakistan is unable to motivate the world giants to manufacture the 765 KV switchgear, in which case the loss of power in transmission would be very high.

To sum up 1 and 2 above, it is a typical problem associated with development of such dam sites, i.e. to transport almost everything to a far off inaccessible site of construction, and then transport electricity in the reverse direction to the consumers market.

3. The 920 feet high dam is proposed to be built in Roller Compacted Concrete (RCC) which is a cheaper and quicker way as compared to the Conventional Vibrated Concrete (CVC). However, because of vulnerability of RCC dams to leakage and cracking, the world engineering communities are proceeding cautiously and gradually by improving methodologies as also increasing the dam heights. China, Japan and Columbia are the three countries in the forefront, and they have achieved record heights of 425 feet, 460 feet and 620 feet respectively in recent years. **Basha Dam height is thus nearly 50% higher than the highest dam so far commissioned. Precedent is an important factor in terms of proven safety of structures where needed expertise lies beyond the known horizon of technology.** In this regard, may I also confirm that one of the three members of WAPDA's Panel of Experts (POE), who has been advocating a huge and risky leap in the case of Basha, despite opposition from other members of POE, has recently and quite rightly been dropped by WAPDA. **Alternative dam materials with proven precedents,** such as Conventional Vibrated Concrete (CVC) or Rockfill Dam with Earth Core, are naturally not being chosen by engineers because the long haulage costs of materials (not locally available), **would make the dam prohibitively expensive.**

If Basha is constructed in RCC (to save on cement quantities, time and costs etc.), leaky joints and ultimate **failure could generate a 500 feet high water wave from the 900 feet deep reservoir, which would travel downstream leaving no other dam (such**

as Tarbela) barrage or bridge across the Indus River intact, washing down everything on way right upto its outfall into the Arabian Sea. River bank cities such as Attock, to mention only one, will get destroyed by slush leaving behind the city under a mound of sediment as high as 200 feet. At some point of time, future generations may rediscover such towns as a part of archeological excavations.

4. The **storage and powerhouse capacities of Basha Dam** have been deliberately **enhanced by certain unscrupulous quarters** with the sole objective of claiming added benefits **to exceed those of the Kalabagh Dam** under a directive given by WAPDA around the year 2002. As a follow up of this otherwise sincere but rather incompetent directive, the height of the **Dam was raised by yet another 33 feet, thereby further jeopardizing the safety aspects.**

In short, almost everything about Basha Dam is superlative and unprecedented; the RCC dam height, the huge underground powerhouses and related facilities; tunnels and structure sizes; 765 KV line with a non-existent switchgear; all of them indeed the world's first-ever. Indeed there are a couple of stunted elements as well, namely the estimated cost and the implementation schedule! Basha Dam needs to be studied far more thoroughly and in depth, may be by also involving experts from China who have worked on similar projects. **A crash study of the type conducted thus far, to say the least, has been an adventurous and risky undertaking that could prove disastrous for the nation.**

With utmost respect and sincerity, my own estimate is that a safe and sound Basha Dam cannot be brought on line much earlier than the year 2018. On the contrary, the Kalabagh Dam which is 260 feet high (compared to 920 feet high Basha Dam), close to the market centers and studied over a period of 15 years, can be commissioned by the year 2012. Conventional wisdom would also demand that the nearer and more economical dam sites be undertaken first, followed progressively by the development of farther and farther sites as the national economy grows.

The **objective** of writing this letter is that your decision on the subject which may be forthcoming soon, is an informed one which, **besides coping with political considerations of a compelling nature, ought to take into account the professional factors as well.**

With kindest regards,

10-A, TECH Society
New Campus
Lahore-54590

General Pervez Musharraf,
President,
Islamic Republic of Pakistan,
Islamabad.

July 09, 2004

Subject: **Dams Dilemma**
A Pragmatic Solution

Mr. President,

You are indeed very well aware of the multitude of problems that lie in the way of construction of future dams in Pakistan.

Firstly, permit me to say that there are powerful environmental lobbies which are totally anti-dam and mostly composed of spoiled children of rich people (some of them have grown quite old now) who have no dearth of water, power, food and all the worldly comforts which the money can buy. Such members of NGOs who are also fortified by foreign money, have to be ignored if we are to develop our available natural resources. In other countries for instance, despite the resistance posed by such groups, currently 280 dams are under construction in China, 960 in India, 209 in Turkey, 463 in Japan as against "none" in Pakistan. Our anti-dam groups do not seem to accept the universal principle that poverty and backwardness of a country is largely attributable to its own failure to develop and utilize its natural resources. A dam site, along a river, Mr. President, is one of the most precious natural resources in terms of its water supply and power potential.

The two Indus storages currently under active consideration are the Kalabagh and the Basha Dams. Contrary to the impression generally prevailing, these two dams complement each other rather than being mutually exclusive. Both of them together would yield some 12 MAF of highly valuable stored water, available for releases in controlled quantities and at required times governed by crop demand, in addition to nearly 7,000 MW of cheap and environmentally clean hydropower. Such additions would more than double the benefits to national economy, that are being currently contributed by Tarbela and Mangla combined.

My next submission is that according to experts who have actually worked on the Karakorum Highway (KKH) and have received exposure to the challenges posed by the faulted and fractured geology of the formidable terrain, a minimum period of 4 to 5 years would be required for its upgradation. Although relocation of some 140 km of KKH to higher elevations upstream of Basha should not pose a major problem since there would be sufficient time available until

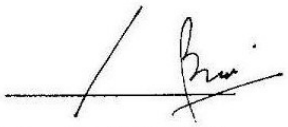
impounding of Basha Reservoir starts, yet the upgradation of approximately 200 km from Thakot to Basha has to be accomplished before the start of dam construction, to cater for transportation of heavy construction equipment and materials. This requires not only greater road width but also more gradual curves on turns and much gentler road gradients. The experts are of the categorical view that since rock weathering is extensive, in many reaches shotcreting, rock bolting, steel meshing, new bridges and short tunnels behind potential slide areas, would be absolutely essential to stabilize the crumbling high-hill slopes. Ironically, all this activity has to be carried out (including rock blasting) while normal traffic is safely maintained. When some of our highway engineers from NHA and their consultants, allocate two (2) years for all this work, I get both amused as well as appalled at their naivety. Constructing Highways and Dams in the Himalayan and Karakorum Ranges is a vastly different ballgame.

Accordingly, KKH upgradation would in itself be a major undertaking which would not permit commencement of construction of Basha Dam any sooner than the periods portrayed on the enclosed "Pragmatic Schedule". At the same time, I fully appreciate that announcement of one particular dam will automatically be construed as a rejection of the other dam. A rational and realistic approach would thus be to announce **simultaneous construction of both the online dams.** In practical terms, this would mean start of Phase-I construction of Basha Dam (KKH Upgradation) concurrently with the construction of Kalabagh Dam. While the construction of both these activities are under way, the outstanding technical problems emerging from the recently – completed "Feasibility Report" of Basha Dam, and its detailed engineering design can be completed without any haste since this work, unlike KKH upgradation, is not on the "critical path". As may be seen from the enclosed schedule, financial peaking of the two (2) dams, under simultaneous construction, will not occur; (1) because the compulsive lag time cannot in any case be eliminated, and (2) the finishing phase of one dam overlapping the start up phase of the second dam, would not cause peaking of financial needs due to much lower degree of activity during these periods.

I hope the foregoing proposal would be of some use to you, Mr. President.

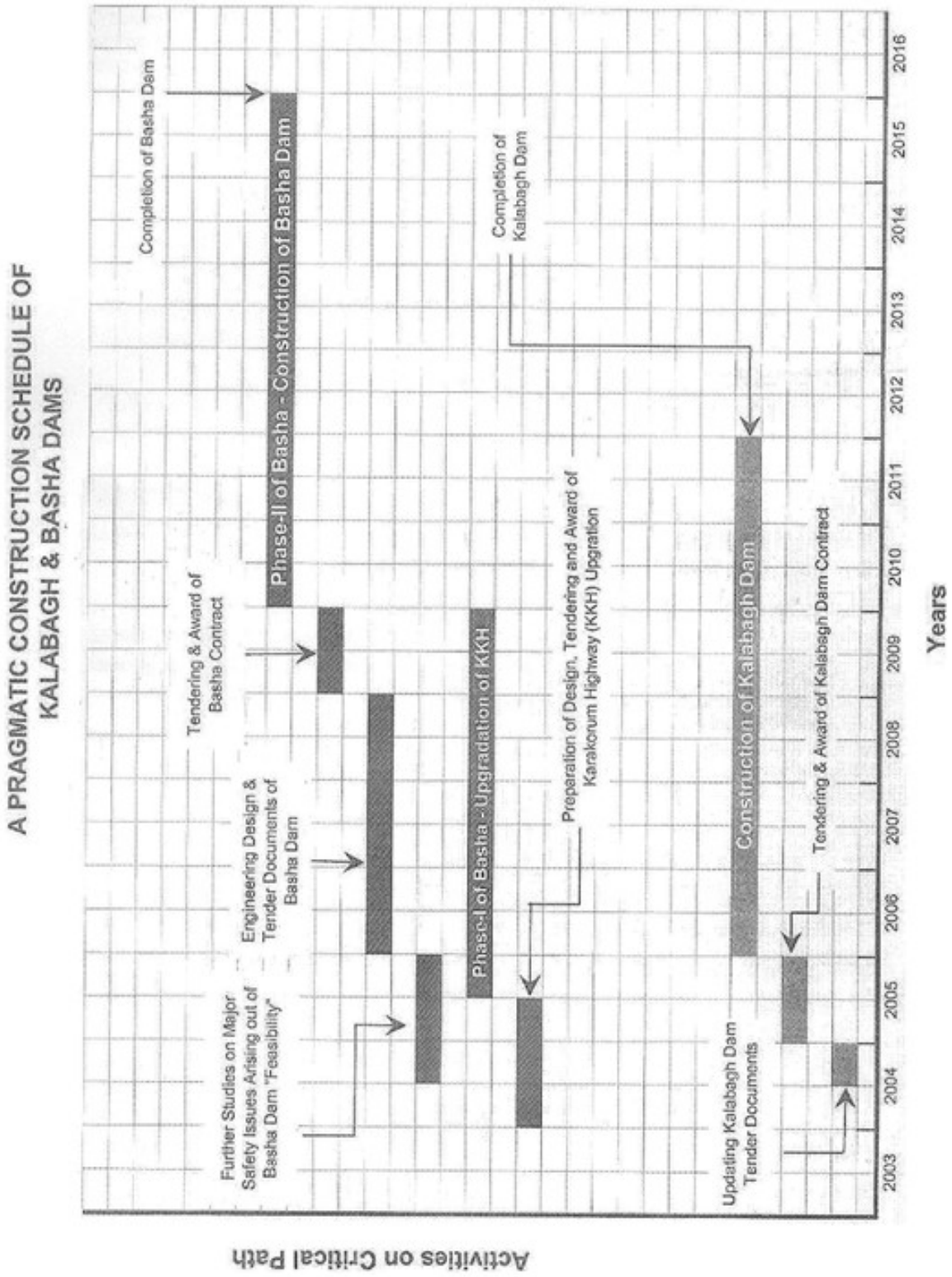
Assuring you of my sincere professional advice at all times,

Yours Sincerely,



Lt Gen Dr G.S. Butt

Mr Shaukat Najib


A PRAGMATIC CONSTRUCTION SCHEDULE OF KALABAGH & BASHA DAMS
Activities on Critical Path
Further Studies on Major Safety Issues Arising out of Basha Dam "Feasibility"
Engineering Design & Tender Documents of Basha Dam
Tendering & Award of Basha Contract
Phase-II of Basha - Construction of Basha Dam
Completion of Basha Dam
Phase-I of Basha - Upgradation of KKH
Preparation of Design, Tendering and Award of Karakorum Highway (KKH) Upgration
Completion of Kalabagh Dam
Updating Kalabagh Dam Tender Documents
Tendering & Award of Kalabagh Dam Contract
Construction of Kalabagh Dam
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Years

SUI NORTHERN GAS PIPELINES LIMITED
21-Kashmir Road, P.O. Box:56, LAHORE (PAKISTAN)
Telephone (Direct): 9201398 / Fax: 9201302
PABX: 9201451-60/ 9201490-99

Lt Gen G. S. Butt
Chairman, Board of Directors

CSN/1
18 November 2004

General Pervez Musharraf
Nishan-I-Imtiaz (Military)/ Tamgha-i-Basalat
President Islamic Republic of Pakistan
Islamabad

It was a pleasure to be with you in GHQ on Friday, October 15, 2004.

You had mentioned Akhori Dam, during our conversation and it is in this context that I am addressing this letter to you. I am also enclosing a paper on Bunji Hydro power project, which is not a water storage project, and is located on KKH. I am also taking this opportunity to send you a brief (really brief) on the role of water wing of WAPDA. Power Wing is being privatized.

Very briefly Akhori Project is an off-channel (off the Indus River) storage project which will be located a few kilometers West of Hassanabdal. It covers approximately 10 square miles area. The West side that is generally an open area and requires two (2) dams to confine and impound water. The combined length of the two Dams, namely, Akhori Dam and a Saddle Dam will be some 12 kilometers. A 33 km long water conveyance channel would be built to transport water from Tarbela Reservoir (Haripur Pocket) when it is at a high pond level stage, to the proposed Akhori Lake Site. The Feeder Channel shall be a concrete lined canal carrying some 80,000 cubic feet of water per second (cusecs). The Reservoir would be able to store as much as 6 million Acre Feet (MAF) of water and will be able to generate 600 MW of electric power.

Akhori Dam's Feasibility Report is currently under preparation. The Consultants are a Pakistani lead firm, ironically with no experience in Dam Design whatsoever but with support from an East German Company, who have indeed worked on several dams, are preparing Feasibility Study which is due for completion in July 2005. Foreign experts are 4 or 5 in number, and with a view to saving costs, the Pakistani Consulting Firm has largely employed Russian Engineers. In Russia a B.Sc. (Engineer) is called a Doctor of Engineering. All the Russian Engineers are doctors of Engineering. Akhori Dam Surveys,

preparation of large-scale Maps with 1 meter contours, crucial subsurface investigations of soil/rock etc., are all excessively behind schedule. The Pakistani lead firm is being run by a smart and intelligent person, and therefore, I believe the Firm will manage to furnish a Feasibility Report with some extended time (Consultants are already sending signals to that effect). More importantly, there are bound to be many missing features and vital questions will remain unanswered. The Report may well turnout to be of the status of what we call a Pre-Feasibility, requiring another year or two to bring it to the proper level of a Feasibility Report. Thereafter Engineering Design and preparation of Drawings and Tender Documents of a Bankable Quality (World Bank), with all the mandatory reviews by independent Panel of Experts, etc and consequent changes, may mean another three to four years. This would mean that the earliest time the construction of Akhori Dam can commence will be by year 2010 with completion likely by y ear 2016.

Accordingly, Akhori Dam, though a promising Project ought to be regarded as a complementary undertaking to the Kalabagh Dam, rather than to consider it as its competitor.

The power generation from Akhori would be merely 600 Mega Watts (MW) as compared to 3,600 MW obtainable from Kalabagh Dam. Yet, if Akhori Dam is completed in later years, its 6 Million Acre Feet (MAF) of stored water will further enhance power generation at Kalabagh Dam because the same water when released during dry months will be passing through the downstream Kalabagh Powerhouse generating substantial quantum of additional hydel energy.

The Feeder Channel offtaking from Tarbela Reservoir to supply water to Akhori Reservoir is not very long (33 km), but it would be a major undertaking. It is much bigger in size than the biggest lined canal recently completed as a part of the Ghazi-Barotha Hydropower Project (80,000 cusecs for Akhori versus 56,000 cusecs capacity of Ghazi Barotha Canal). Although the Reports mention it as a 26 feet deep channel (meaning the water depth), the actual excavation may exceed several hundred feet at places because of high terrain enroute. The conveyance channel, in fact, of this unprecedented size will pose many problems which indeed can be solved, but my point is that Engineers should not be made to rush through the Engineering Design to unduly save time, otherwise we may end up in a costly and time – consuming disaster situation.

The cost estimate of Rs.86 billions is merely a guesstimate, and in my view is grossly underreported. The Akhori Dam 5 km long, 420 feet high, and an essential Saddle Dam 7.8 km long and 170 feet high, have a combined volume that is as much as twice that of the Tarbela Dam!

I would, of course, have more comments when the Feasibility Report is issued by the Consultants. Meanwhile, Mr. President, let me say, that;

Akhori

1. Water-wise, Akhori Dam appears to be a promising project for conservation of badly needed water.
2. Power-wise its contribution on its own would be very small, however, with Kalabagh already there, Akhori Reservoir can genuinely and rightfully take credit for the incremental power generation at Kalabagh.
3. Time-wise, the Engineers must not be pushed so hard that the very safety of this wonderful but otherwise complex Project, is jeopardized.
4. Priority-wise, Kalabagh may be finished by the year 2012 followed by Akhori in the year 2016. A properly designed and constructed Akhori Dam Project is bound to take that much time. Therefore, the two Projects are complementary in nature and not mutually exclusive.

Mr. President, please permit me to reaffirm my earlier conclusion that a major storage must come on line at the earliest possible time, latest by the year 2012.

Needless to reassure you that I would be available any time and at all times to render my sincere professional advice whenever you may need it.

I remain,

Yours sincerely,

GS Butt

Lt Gen (R)
Dr. Ghulam Safdar Butt

Anx – 2

Bunji Hydro-Power Project

(No storage needed)

WAPDA's announcements about looming power shortage, unavoidable loadshedding and expensive IPP oil based thermal power generation are cause of concern. Import of fuel oil would further strain our fragile economy. A hydropower project which has low gestation period, produces cheap energy and is not handicapped by political controversies, is required.

Bunji Hydropower project, on the Indus River 42 Km South of Gilgit, is a promising project. Consultancy work is already in hand.

- ◊ It can be completed by year 2011
- ◊ Project cost is $ 4.0 billion (spread over 6 years)
- ◊ Cost of energy would be 2.3 Cents per Kwh (as compared to IPPs 6.5 Cents and Thar Coal at 4.5 Cents)

The Project will generate 5000 MW, 22,000 GWH greatly helping in reducing oil import bill, will produce power before Kalabagh & Basha and has no population displacement or controversial political problems.

If there is an element of urgency we can start the civil works in mid 2005.

KKH may follow Kunhar Valley route, which would be 160 Km shorter and can be done within two years.

Anx – 3

Reorganization of Water Wing of WAPDA

WAPDA was created on the model of Tennessee Valley Authority (TVA), to provide cheap electrical power, flood control, irrigation water etc, by developing the potentialities of the Indus River and its tributaries. It has now been decided by the Federal Govt to privatize power wing of WAPDA. Power Wing provided cash to finance all development projects. When power wing is privatized the water wing of WAPDA would be starved of working capital.

The infrastructure and expertise developed in the past few decades would be dispersed and lost to the country. We already suffer from acute shortage of technical and managerial ability. We may not be able to afford further loss.

I propose River Management Authority may be converted to Water Wing of WAPDA or vice versa.

It should be charged with the responsibility of developing Hydel power, upkeep of barrages and flood control. The division of responsibility between the Provincial Irrigation Department and the new entity can be amicably worked out.

Its HQ could be in Islamabad and the four support offices in the four provincial capitals.

This may well have been the original concept when creating WAPDA, many decades back. Initially the Chairman WAPDA were Messers Ghulam Farooq, Ghulam Ishaq, A.G.N. Qazi and I.A. Khan. Let the chairmanship not be confined to the engineers alone. Let them be industrialists, politicians, army officers, civil servants and even suitable foreigners. We are looking for proven leaders with management capabilities and creative minds.

TVA has grown big to include even nuclear power whereas WAPDA is shrinking because of poor leadership. The four, named above, created WAPDA and they were not engineers but visionary leaders.

15.2 A Letter from Lt. Gen (R) Dr. G. S. Butt to Chairman WAPDA (2004)

Lt Gen G S Butt

10-A,TECH Society, New Campus,
Lahore-54590,Pakistan.

30th June, 2004

Mr. Tariq Hameed
Chairman
WAPDA, Lahore

my dear Tariq,

It was kind and generous of you to invite me and my colleagues for presentation and discussion on Basha Dam. We are very grateful to you for your kind hospitality.

Although you were making comprehensive notes during discussion, however, to refresh your memory I am writing this note to highlight the points, which were raised by us.

KKH

The up-gradation contract may be awarded to an international road builder. Please also include the Chinese Contractors. The contract could be EPC type (Engineering, Procurement, Construction). The work has to start from Havellian in order to smoothen the grade and widen the horizontal curves to take loaded Multi axle trucks. Work would include slope stability, rock bolting shot creting, and wire mesh. Also Toe stability, like on M2 road in salt range with gabions. Rock below the road level has adverse dip and needs stability treatment with rock-bolting etc. Overhangs to be cleared and upper slopes stabilized. Geology along the road deserves in depth study, which has not been done. Your transport consultant needs to be more knowledgeable. He was talking about 8% gradients, nothing would move on such a gradient except a 4 x 4 Jeep. Heavy transporters in Pakistan are 50 ft. long, carrying 70-100 tons load and have 6 axles. Please inform your road

Tele: 92-42-5420392, Fax: 92-42-5420411

consultant. Design speed 30 MPH, paved width 24 ft with 4 ft shoulders and laybye, slope max 5% , horizontal curve max 27 degree or 300 ft radius, level curves, except for super elevation.

Give the road maintenance contract to the main contractor in order to avoid liquidated damages and delays. Upgradation would take a minimum of four to five years, keeping in mind that the road has to stay open for normal traffic.

POWER TRANSMISSION

Apart from the narrow Indus Corridor there is need to explore other corridors, which have not been done. Please consider 1000 KV DC amongst other options. We need to bring out a lot of power from other projects up and downstream of Basha on Indus. Let there be a Karakoram Electrical Bus capable of catering for future power flows. It is understood that two 1000 KV DC circuits could carry power in excess of 15000 MW. At the moment there is no corridor available even to construct a four 500 KV AC circuits required for Basha alone. We must be able to cater for future growth. Let the present cost benefit the future projects.

HEIGHT OF DAM

Survey is faulty. Please rectify.

Follow ICOLD (International Conference On Large Dams) definition. There is nothing like "Effective Height".

There would be vertical expansion/contraction joints in the dam. The central section of the dam would exert its full height during an earthquake, as per ICOLD.

3

Consider also a flexible rock filled dam with RCC cloaking. Do not allow the consultant to follow their hunch or first available solution. Every critical option and parameter must be considered in detail and only then discarded.

TECTONICS

This is a dangerous area to build a dam. The prosperity and survival of the country depends on this and other dam. Geology of the area has not been fully studied.

The dam axis has been decided without much investigation and is most inadequate. A lot of work needs to be done.

Jaglot syncline is a highly active tectonic element. Basha is located within its stressfield where tectonic movements are permanently going on. Frequency of heavy earthquake is considerable. Their epicenters are not too far. More detailed and precise investigations are necessary. Recent (2002) earthquakes in Nanga Parbet Massif (NPM) can initiate several landslides. If that happens after the dam is built and a wave is generated that may fail the dam and spill over it. The downstream devastation to Tarbela and all other barrages, upto Kotri would be enormous. I shudder at the thought.

GENERAL

1. **The dam main design may be done by a consultant other than the Feasibility consultant otherwise the mistakes would be compounded. MONENCO of Canada wanted to play this game and has landed the country in trouble. Let no one get through the back door. Let it be an open competition between people who have made dams successfully, not just an irrigation or a drainage ditch. Let the glib talkers wait out.**

Basha is top ranking after Kala Bagh dam. Let this be corrected. Your consultants are following MONENCO trick and may again land the country in trouble.

2. **I do not enjoy people pulling wool over my eyes to get their points through, which some people tried yesterday, of course I let it go un-noticed because I was not there to score points.**

3. **Kindly give due consideration to the height datum issues raised by Ch. Mazhar Ali. (Height of Dam).**

4. **Basha cannot be compared to the much smaller Meil Dam, in Columbia. Seismology is the critical reference here.**

5. **Kindly take note of Waseem Khan's fax comments to you about the pitfalls of having two power stations. The cost of running two stations cannot be justified.**

6. **Basha Dam may be a cheap source of energy but its location requires cautions deliberation. We must thoroughly evaluate the risks Vs the benefits.**

7. **Whereas we need both Basha and Kala Bagh Dam but a forceful competition is being created, as a reckless adventure by the consultants. The height to create bigger quantities of water and power while simultaneously cutting down the costs and construction periods to make one dam look better than the other, all at a colossal professional risk quite needlessly.**

8. **When panel of experts (POE) arrive for four days and are handed over seventeen volumes. They don't even have time to critically evaluate this executive summary. All they say is satisfactory/good. They cannot afford to lose $ 1500 per day plus perks and expenses and the glory that goes with being on the POE of a large dam, and future opportunities and added experience under their belt.**

9. **I have liked your idea of starting both dams simultaneously. In this period you would able to upgrade KKH and complete the geological and other studies.**

10. **Two power stations appear to be a political rather than a technical consideration. The consultant has followed outside dictate to influence their judgment, just like MONECO did. Let the issue be decided judiciously.**

Regards. I am at your back and call whenever required, provided you can tolerate my blunt letters – all in good cause and with good intentions.

Yours Sincerely,

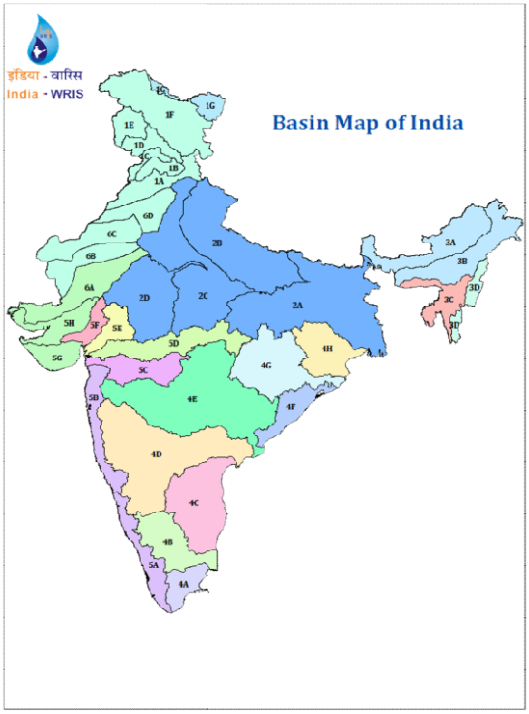
Lt. Gen. Dr. G.S. BUTT (R)

Appendix: River Basins of India. Classification underAISLUS Basin.

The AISLUS organization of the departments of agriculture and co-operation has been engaged in conducting rapid reconnaissance surveys for prioritization of smaller Hydrologic units within catchment areas of river valley projects and flood prone rivers.it has developed a system for delineating and codifying the catchment areas into smaller Hydrologic units i.e. sub watersheds following the 4 stage delineation. Through the methodology developed has been serving the requirement of prioritization, a need for national level framework of watersheds, was always felt by the user agencies. The present bulletin on watershed atlas of India is an endeavor in that direction wherein the entire country has been divided into:

- 6 Major Water Resources Region
- 35 River Basin
- 112 Catchments
- 500 Sub-catchments
- 3237 Watersheds following a 5 stage delineation approach

Sr. #	Basin Code	Basin Name	Area(sq.km)
1	1A	Sutlej	53108
2	1B	Beas	20187
3	1C	Ravi	13626
4	1D	Chenab	29945
5	1E	Jhelum	29513
6	1F	Indus	138613
7	1G	Ephemeral incipient drainage not flowing into Indus	28676
8	2A	Lower Ganges	296614
9	2B	Upper Ganges above confluence with Ghaghra	207557
10	2C	Yamuna	212829
11	2D	Chambal	136593
12	3A	Brahmaputra right bank upto Lohit confluence	105416
13	3B	Left bank ok of Brahmaputra	107133
14	3C	Brahmaputra tributaries that flow into Bangladesh	56093
15	3D	Eastern parts Manipur and Mizoram draining into Chidwim(Burma)	28320
16	4A	Cape Comorin to Cauvery	37564
17	4B	Cauvery	84654
18	4C	Between Cauvey and Krishna	143845
19	4D	Krishna	271444
20	4E	Godavari	315076
21	4F	Between Godavari and Mahanadi	53949
22	4G	Mahanadi	141875
23	4H	Mahanadi to Ganges water resource region	84326
24	5A	Cape Comorin to Sheravati	54771
25	5B	Sharavati to Tapi	58146
26	5C	Tapi	66652
27	5D	Narmada	95879
28	5E	Mahi	39712
29	5F	Sabarmati	26967
30	5G	Southern Kathiawar	39322
31	5H	Draining into gulf of Kutch	58257
32	6A	Luni and other drainage into Rann of Kutch	92518
33	6B	From luni to Jaisalmer	58489
34	6C	Jaisalmer and Bikaner	69697
35	6D	Rohtali to Ambala on east and Ganganagar in west	52582



Introduction of River Basin in India:
River basin is considered as the basic hydrological unit for planning and development of water resources. There are 12 major river basins with catchment area of 20000 km^2 and above. The total catchment area of these rivers is 25.3 lakh km^2. The major river basin is the Ganga-Brahmaputra-Meghna , which is the largest with catchment area of about 11.0 lakh km^2 (more than 43% of the catchment area of all the major rivers in the country). The other major river basins with catchment area more than 1.0 lakh km^2 are Indus, Mahanadi, Godavari and Krishna. There are 46 medium river basins with catchment area between 2000 and 20000 km^2. The total catchment area of medium river basins is about 2.5 lakh km^2. All major river basins and many medium river basins are inter-state in nature which cover about 81% of the geographical area of the country. **There are five classifications.**

16. REVIVAL OF WAPDA: A MULTI-FACETED BLUEPRINT FOR SURVIVAL OF THE PAK ECONOMY. ENERGY Vs POWER

Suleman Najib Khan

Preamble: The vital role of WAPDA in Pakistan water based economy can be appreciated from the fact that in 1969 the Federal Budget was PKR 1,750 m while WAPDA's budget was PKR 2,500 m.It was repeatedly declared by the multi-laterals as the finest utility in the developing world. Today it is a decimated organization unable to finance its vital projects. **It is permitting projects such as T-5 on the Tarbela dam 5th tunnel without a feasibility study.** Those of us who know Tarbela are certain that T-5 proposed powerhouse of 1310 MW installed capacity will have a plant utilization factor of less than 10%. Perhaps it could operate during the monsoon flood season. There is a 100% certainty that to justify this incompetence WAPDA will shut down generation on tunnels T-1 & T-2. This would be an economic crime and it is time for reflection on the state of affairs of WAPDA where its management is unable/unwilling to advice Islamabad that installed capacity in MW is not a guarantee that energy (MWh/GWh) will be available. Even the T-4 enhanced to 1410 MW will be depreciated after DASU HPP or DBD.T-5 makes Akhori off-channel storage redundant.A disaster for the Post-Tarbela scenario.

It was in Feb 94 when Mr. Mustafa Khar the newly appointed Federal Minister for Water & Power of the PPP government made his maiden appearance to preside at a seminar in the WAPDA Auditorium. The occasion was the presentation of the new Private Power Policy draft; its highlights & objectives. A class fellow from university Mr. Tanvir Azhar (late) was conducting. Tanvir was indeed a brilliant electrical engineer & mathematician. He had rapidly risen to the level of General Manger in Nespak. The Energy Czar of the PPP government Mr. Shahid Hassan Khan had nominated Tanvir as the first Director General of the Private Power & Infrastructure Board (PPIB) Islamabad. Tanvir's book 'Quest for Power" was an excellent treatise of his mathematical skills and his power system control & data acquisition work at Nespak for the WAPDA network. One had been aware of the basic recommendations of the TASK FORCE on Energy (Jan 94). My serious concern was that any new power policy which is uncapped will destabilize WAPDA, eventually the national economy & ultimately damage the Federation. One was also aware that OECD Helsinki Accord of August 1992 was the pretext for radical changes in financing of public sector infrastructure including power systems and had brought along my article 'Statement on Electric Power'. In the recess Tanvir read it. He said "Suleman this is a meaty article but we have decided that WAPDA has to be dismantled and privatized. The new Power Policy to be announced next month (March 94) will be inviting Independent Power Producers (IPPs) and the ban on WAPDA constructing new thermal power stations will remain". The Hub project was now being blessed with its progeny before the impact of its Power Purchase Agreement (PPA) is assessed. The oil import lobby was clearly winning. Tanvir, God bless his soul, was commercially naïve.

16.1 WAPDA weakened by design:

It is modeled on the TVA which is America's most successful civilian project. The willful destruction of its balance sheet is a national calamity. It was only nine years ago when the Indian Army COAS declared and translated verbatim "Every proposal in opposition to Kalabagh Dam is like a new nail in the coffin of Pakistan's defense capability". Soon thereafter a three member Indian delegation to an Islamabad conference declared that Indus Waters Treaty 1960 is redundant & superfluous! Not a single PAK functionary reacted. It is quite apparent that the induction of non-technical bureaucrats in Engineering Organizations has been a major factor in the nation's economic plight. In WAPDA's nascent developing stages it was fortunate to have had visionaries such as Ghulam Ishaq Khan, Ghulam Faruque Khan & I.

A. Khan. They were trained to seek advice & work as a team. They could study the financial impact of every step.

Why did PM Shaukat Aziz again block WAPDA in 2005/06 from building 2000MW of thermal power based on combined cycle P.S (gas fired) after allowing their construction in 2004? Above all why he was hostile to construction of hydro-electric (hydel) power stations on fast-track basis. MoUs were signed in Dec. 2001 with top PRC corps in the presence of the President. He blocked and cynically derailed hydel run-of-the-river projects (primarily in the public sector) during the period 2003/04/05. He actually scuttled US 2 cent hydel projects (zero fuel costs) on the untenable basis of supplier credit interest rates being 5.5% pa against his demand of 5% pa. The NPV of the hydel projects he blocked are many multiples superior to the private oil based projects he supported. This smooth talking banker acting as an economist ensured that Pakistan is held hostage to the oil lobby. A fatal embrace after the escalation of oil prices. Mr. Aziz forgot that in May 2000 he had gone to Beijing, cap-in-hand, for a roll-over of USD500 mn which was the bulk of Pakistan's Forex Reserves. Why did plans such as the 1994 National Power Plan go into cold storage? Later Mr. Shaukat Aziz unleashed Mr. Shakeel Durrani, an ANP nominee, on Pakistan and turned a blind eye when he was blocking critical hydropower projects as CS NWFP and later as Chairman Pak Railways attacked his own predecessors on their purchase of Chinese DE locomotives. Can the nation forget that in year 2000 the Chinese people were the only friends willing to finance our infrastructure development and even rolled over the critical Forex reserves with the State Bank? More mischief followed.

The seat of Chairman WAPDA had been reserved for a political group whose declared policy is "No more reservoirs on the Indus". Mr. Durrani (Chairman 2007 – 2012) did not spend more than a week in his office every month. He would demand that the 96MW Jinnah Low Head project be expedited while the 3,600MW KBD, few km upstream was willfully ignored. His successor Mr. Raghib Abbas Shah followed his anti – KBD agenda although he was a WAPDA engineer.

16.2 WAPDA again our economic Prime-mover ~ Roll back Roll back Roll back.

Revive WAPDA as per its original charter of 1958. Both irrigation water distribution and electric power distribution are provincial subjects. It will be a very logical step. It will stem the rot as the corruption level and inefficiency of DISCOs is reportedly intolerable. Their privatization would be even a bigger folly as 27 years of private distribution after 1947 proved. Let WAPDA be the supplier of bulk water (as at present) and also bulk electric power to the provinces. Design and Construction wings of WAPDA be kept intact as it would take decades to duplicate them at the DISCO level. NTDC the bulk transmission company has to be returned to WAPDA as this is a critical arm of the energy producer. Give the goal of low-cost electric power (SASTI-BIJLI). A five years program at the most. A fall back on indigenous thermal resources however painful. Run of the river private hydels allowed on raw sites and given fullest support with a fair tariff regime. There are fast track projects (run-of-the-river) having medium to high heads where generation is possible at less than US 3 cents. Let plant utilization factor determine its size. Its location upstream of Chilas has to contend with the challenges of very long transmission lines and the seismic factor. Economic dispatch be strictly monitored and only the least cost solution be favoured. This Chapter 16 and Annexure-F present The Great Indus Cascade (2015-2040). Four dams & four HPPs with a cumulative capacity of 29,000MW capable of 104,400GWh energy p.a.

16.3 Neelum Jhelum 969MW HPP: WAPDA has used a false pretext.

There was no race between Indian IHK & Pakistani projects. WAPDA continues to state that whoever builds first will have perpetual rights over the Neelum waters. It is a cover to conceal the failure of the PCIW who did not respond in time to the Indian project announcement. Infact the Pakistan response was six years late. The flow of the western rivers are perpetually Pak endowment and for the

"uninterrupted use" of Pakistan as repeatedly stated in the IWT 1960 and may only be ignored at Pakistan's peril. The IWT 1960 is sacrosanct. The longer tunnel option at N-J HPP & higher DBD both have the treacherous purpose of distracting the nation from the most critical KBD project. How much contractual loss will be suffered by the people of Pakistan who are paying a Neelum Jhelum surcharge with every electrical unit in their utility bills? In fact the project is further burdened with additional costs for operating TBMs instead of the economical "drill & blast" method originally agreed & signed for in the contract. WAPDA admits in March 2015 to a fourfold escalation of costs. The News items appended.The nation has to review this in light of the two judgments of February 2013 and December 2013 by the PCA (Permanent Court of Arbitration). PCA supports the Indian Kishenganga project with the exception of declaring 9 cumecs as the minimum environmental flow downstream. Both PCA abstracts in Annexure-E.There has been an incidental judgment against low level sluicing gates which will ensure that the technical set-back in the Baglihar-I (decision by Neutral Expert) will not be repeated for future IHK Projects.

Neelum Jhelum tunnel project is around 5 years away. The illogical decision to ignore the first feasibility report of 1987 and follow the later 2nd option to tunnel under the upper limb of the Jhelum Main & place the power house at the lower limb of the Jhelum thereby increasing the total tunneling to +60km is a financial disaster in the making. A project that could have met its strategic objectives in less than USD 1bn (with completion in five years) has been pushed to an estimated project cost of +USD 5bn with completion now estimated in 2020; some 12 years after work commenced in 2008. The world's most expensive HPP.

It is a blatant misinterpretation of the IWT 1960 to discuss a race with India's Kishenganga HPP (the Indian name for Neelum River). It is a story to scare the nation. Logically the larger & much more expensive tunneling would not have been taken if there was a need for a race between Kishenganga HPP & Neelum Jhelum HPP. Procurement of TBMs (Tunnel Boring Machines) has been during 2010-2011 the obsession of the WAPDA Chairman Mr. Durrani (and his immediate successor) inspite of the dubious technical benefits in the particular soft soil conditions. Starting from Norconsult who were the first to study this project, 25 years ago, to the present project consultants no serious recommendation has been ever made in favor of using TBMs. The WAPDA management failed to obtain a clear & favorable consultancy report. Finally they used the TBMs as a bait for the PRC contractor. A quid pro deal where he would supply the two European TBMs on the plea of earlier completion of Neelum Jhelum tunnel hydel project. WAPDA claimed two years will be saved but concealed the fact that TBM delivery / commissioning by its supplier would also require two years. The contractor will not only be forgiven some years of delay; but can also justify future delays in construction. Will these TBMs justify their cost in Neelum Jhelum soft rock & clay? TBMs will be clearly facing the prospect of being trapped upto 2.5km below the surface. These expensive moles have been deployed for 9.1km out of the 28.54 long Headrace twin Tunnels. "Drill & Blast" method still applies for the balance works of N-J HPP project. India has won the imaginary race; they "called our bluff" & stole our water rights.

If CIBSA had existed the most expensive HPP in history would not have been permitted. The Neelum Jhelum HPP (NJHPP) is heading to be the World's most expensive hydropower project and was started after the case for Pakistan's project downstream was already a lost cause. In 1994 India had the legal upper hand and had snatched the water rights for the KG HPP because of the incompetence of PCIW. The decision of the Permanent Court of Arbitration (PCA) as received in February 2013 and the complete decision in December 2013 were simply a fait accompli. It is our prediction that the downstream project inside AJK known as the Neelum Jhelum Hydropower Project (NJHPP) which involves nearly 60 km of tunneling including tunneling below the Jhelum will cost more than USD 5 billion when commissioned. The expected power rating of 969 MW will not be achieved due to higher hydraulic losses. The expected energy output of 5,000 GWh (5 Bn units) will reduce drastically during the seven (07) months of low flood season (mid August to mid March) when Indian will only permit 9 cumecs (318 cusecs) flow as decided by the final PCA judgment of December 2013. Infact 86.8% of water representing nearly 0.9 MAF will be diverted by the Indian KG HPP to the Bonar Nallah and

effectively to the Wullar lake also inside IHK. It is clear that no one will take responsibility for this financial disaster of NJHPP because its main proponents in WAPDA included Ex-Chairman Tariq Hameed his successor Ex-Chairman Shakeel Durrani and Ex-Member Water Raghib Abbas Shah.

16.4 The case for Large Dams & HPP: Proposed Indus Cascade (2015-2040)

The Proposed Indus Cascade (2015-2040) is presented here as the integrated development of the Indus Main. A 25 years national program which ensures optimization of all projects which are clearly interdependent. This is to ensure highest level of efficiency for the entire cascade starting from the Shyok Dam (190m from rock bed) on the Shyok river, a major tributary of the Indus Main. Immediately downstream of Skardu town another dam of 120m height from river bed. These two dams will provide extremely useful sediment control and permit a huge increase in the energy output of Bunji HPP (a 7200 MW HPP which would be able to work at much greater efficiency). Infact it is estimated the due to Shyok Dam there would be an increase of 30,000 GWh in energy output at Bunji HPP+DBD+Dasu HPP+Pattan HPP & Thakot HPP. Secondly because of Skardu Dam another 10,000GWh would be available at the above power stations of the cascade. This additional energy is in addition to the 640 MW power base of Shyok Dam providing 3,750GWh energy besides a 3 MAF dead storage of its reservoir. The Skardu Dam having 1200 MW power based will also provide 5,500GWh of annual energy.

The Indus Cascade (2015-2040) projects are Shyok Dam, 190m dm height with a 3MAF dead storage and 8MAF gross storage, could give more than 100 years sediment free operation of Bunji HPP in the cascade. Skardu Dam with a height of 120m from riverbed with a live storage of 3.2MAF (gross 4.4MAF) could generate 1200MW. Bunji HPP is 7200MW at plant factor of 39% and 24,300 GWh capacity. Bunji is recommended with 20 units of 360MW. It is better to have more turbines for easy O&M. Raikot HPP with 110m height will generate 1800MW energy. DBD with height of 200 m above riverbed as Concrete Faced Rockfill Dam (CFRD) with a capacity of 3400MW. Dasu HPP, Pattan HPP and Thakot HPP will generate 4300MW, 2300MW and 4000MW respectively. **Refer Annexure-F for details.**

16.4.1 No Privatization of Dams~ Wake up Wake up Wake up. Tarbela T-4 & T-5 HPP

There is no question of allowing private control of any major Dam as advocated by the Shaukat Aziz, Administration. The proposed fourth extension (originally 960 MW) of Tarbela Dam power generation capacity by the private sector based on its fourth tunnel would have been a great cruelty against the people of Pakistan. Firstly it was considered as a peaking project; able to in a good year generate only about 1900 GWh (1.9 Bn units) of electric Energy. Secondly we may not create competition between the private and public sector for the limited quantity of water available. Thirdly and equally important is the fact that a Dam may not have two or more power stations as it raises operating costs. This project was first conceived in an Inception Report prepared by Nespak & Chas T. Main in May 1991. It was first proposed in 1995 for construction on suppliers credit by Sulzer Hydro by the installation of two turbines on available tunnel No.4. The units were to be identical to the four units on tunnel No.3 but rated higher at 480MW instead of 432MW each. Due to safety concerns (sediment sluicing) it was shelved.

It must involve sediment sluicing from Tarbela tunnel No.4 which could use a bifurcation to alternate between the power house generation and required sluicing of sand silt and sediment. WAPDA's Chairman between 2007 & 2014 were diabolical and self-serving persons following the leads of the ANP etc. This project now known as T-4 has been increased to 1410 MW and is under implementation. Unfortunately there is insufficient water at the Tarbela reservoir except during flood season. The project will not achieve 2300GWh energy output. It is clear the 4 units on Tunnel # 1 (total 700MW) and periodically the 6 units on Tunnel # 2 (1050MW) will be shutdown to justify this HPP extension on T-4.

Sediment sluicing was the original purpose of this tunnel. The power generation element has to permit the sluicing function.

The move to use the Tarbela T-5 tunnel for an additional power generation of 1310 MW is a cruel charade initiated by Syed Raghib Abbas, Ex. Member Water & Adhoc Chairman of WAPDA for about one year till early 2014. As a sympathizer of the Indus Forum he was constantly opposing KBD and to some extent DBD. He has set into motion the enlarged T-4 project and set the tone for the T-5. This project of T-5 is recommended to be started without a feasibility study, something unprecedented. The plant utilization factor of T-5 is estimated to be below 10%. Its operation will involve the shutdown of both tunnels T-1 & T2. After the construction of DBD or even the Dasu HPP there will be no water left for T-5 operation. The nation must note that the Tarbela dead level is above 1380 ft. asl. The conservation level at 1550 ft. asl is reached for a few days only. Tarbela is a sick dam. It is unfortunate that the political government is being misled by MW capacity when the energy element is negligible.

16.4.2 CIBSA; Global warming & the water bomb:

The floods 2010 have confirmed that our Sindhi brothers' infact drink surface waters (river canal & lake) inspite of the chemical pollutants. Their ground water is generally brackish & full of pathogens; unfit for human consumption. The nation will have to build several mega dams in cascade. Hydraulic efficiency & energy output of all three dams would be greatly enhanced if DBD – Tarbela – KBD cascade is available giving a bounty of over USD 50Bn per year. Pakistan needs a think tank for its hydrologic analysis. The inter-provincial water disputes became manageable after the Water Apportionment Accord (WAA) in March 1991 & the creation of IRSA as a result in 1992. However both PCIW & IRSA lack the required punch due to deficient technical depth & commitment. In the case of PCIW secretariat it is shamefully under-equipped to face a diabolical, merciless & relentless upper riparian neighbor. PCIW must not depend on Indian data. The Indians clearly worship a water-god as their actions have shown since 1946.

If CIBSA had existed the T-4 HPP extension of Tarbela Dam would remain a 960 MW installed capacity HPP capable of 2000 GWh (2 Bn units annual). The new enlarged rating of 1410 MW will not bring additional hydro based annual energy. The cruel bluff being enacted by the same consultants of Tarbela T-4 HPP project now claim to have designed another HPP extension (T-5 HPP) of Tarbela Dam using the irrigation 5th tunnel. WAPDA has given the "go head" and the design has been approved by CDWP/ Planning Commission **without a feasibility study**. This project will be a criminal act as surplus water will not be available for this project whenever any upstream project on the Indus is ready. An upstream storage would greatly reduce the surplus flows at Tarbela. Also the Akhori off-channel storage project designed to take surplus flows of Tarbela reservoir would stand eliminated. Are powerhouse extensions on main dams built for flood seasons? The T-5 Project would endanger the Tarbela spillway as the inevitable higher intake (for sediment free water) will be constructed in close proximity of the spillway. All the drawbacks of a T-5 HPP Extension of Tarbela are detailed in Chapter 16, focusing on WAPDA.

16.5 WAPDA Facts:

16.5.1 **The TVA model was used to create WAPDA in 1958:** President FD Roosevelt when faced with the aftermath of the 1929 market collapse had to highlight and exploit USAs unutilized potential under the New Deal. He correctly decided that seven contiguous States had the water resources and the land. The TVA was launched and an institute was created in Mississippi where the best available talent amongst military and civil engineers was brought together. A series of 26 dams and associated irrigation channels as well as flood control structures in addition to malaria control and fertilizer production were included in the program. The project stimulated the entire US economy and the benefits that ensued were so great that the USA was ready to face Hitler's war machine. *TVA remains a priceless jewel of the US economy.*

The historical letter of 6 Sep 1951 written by Mr. Eugene R. Black the President of IBRD (World Bank) to PM Liaquat Ali Khan and its enclosed 10 page article; Another KOREA in the Making? by Mr. David E. Lilienthal as published in Colliers on 4 August 1951 is the starting point of the up-gradation of the IBIS. It starts the dialogue to address the core issue of water distribution between India and Pakistan. A statesmen like initiative with President Trumans blessings. Mr. Lilienthal displays great altruistic sentiments. One of his classical observations. The partition gave the major part of the irrigated lands of the Punjab and Sind to Pakistan; but the headwaters of some of the largest irrigation canals that feed Pakistan were left with India or Kashmir. All the rivers upon which Pakistan depends for life originate in India or Kashmir. Two thirds of the entire water supply originates in Kashmir where the snow-fed Indus rises. Finally in 1958 President Eisenhower gifted the TVA model in the form of WAPDA.

16.5.2 **IWT 1960:** The largest asset base of Pakistans economy i.e. the Indus Basin Irrigation System (IBIS) was now having a reservoir building organization to provide the water resources. The IBIS can remain an efficient machine as long as it has necessary water. WAPDA was a timely gift from the Eisenhower administration. On 19 Sep 1960 the Indus Waters Treaty was signed by Pakistan and India with the World Bank acting as a facilitator and guarantor. The signatories were Indian PM Mr. Jawaharlal Nehru and Pak President FM Ayub Khan. The very basics of the treaty's terms were that India would be allowed the exclusive use of the waters of the three eastern rivers Ravi Beas and Sutlej while Pakistan was given till eternity the three western rivers; the Indus Jhelum and Chenab. It was expected to utilize the available marvels of the IBIS known as link-canals to keep alive the Ravi and Sutlej in its territory. New reservoirs were now needed. India was allowed run-of-the-river generation of Hydro-Electric Power on the western rivers. The use of low-level gated structures was not permitted. Pakistan conceded that additional irrigation water could be taken for irrigation in Indian controlled Jammu and Kashmir from 0.6mn acres in 1960 to 1.3mn acres. The water quantity being undefined. Today India is also taking unfair advantage of this concession by Pakistan.

16.5.3 **Mangla dam on the Jhelum river as a replacement reservoir under the IWT 1960** was quickly constructed. Preparation for constructing the worlds largest earth filled dam (Tarbela) on the Indus were accelerated. The World Bank was committed to finance one dam on the Indus and to help improve and enhance the utilization of the existing man made irrigation system inherited in 1947. School children in Europe were reading about the coming green revolution in Pakistan. The core issue was to keep WAPDA vibrant but we failed to follow through after Tarbela dam was completed in 1974. Eight link canals were built after 1960. The Chashma-Jhelum link canal was also added in early 1970s but no further reservoirs were added after Tarbela. The post Treaty (IWT 1960) eight additional link canals are therefore underutilized. The productivity of the largest asset base i.e IBIS depends on the support it can receive from the second largest asset base (WAPDA). A weakened water-short IBIS is now unleashing cataclysmic tendencies starting with social disorder and will lead to total anarchy. The IBIS is a very large machine and can only remain prolific with the help of large reservoirs to sustain Pakistan's economy. *In any case small dams cannot be built on large rivers.*

16.5.4 **Irrigated Agriculture will remain the back bone of Pakistans economy:** It also provides the raw material for the textiles which is Pakistans main industrial sector. It accounts for atleast 90% of its agriculture production. It is based on our largest asset the incredible IBIS. An asset in excess of USD 700 Bn (at today's replacement value). This irrigation machine is water short since the early 1990s. The nation cannot maximize the agriculture output from the 42ma irrigated area. This does not include 12ma barani i.e. rainfed areas. Shortages mean that we cannot bring under cultivation the 21ma lying fallow. Not only additional acreage could be added but the additional water would permit triple and quadruple cropping patterns. Before year 2000 the water availability per capita went below 1 AF per year which is tragic as it means the nation is now water starved. The prolific IBIS machine is water short. The future is bleak.

16.5.5 **No large dams have been built since Tarbela (1974):** In fact the cumulative reservoir capacity of Pakistan has been reducing since 1974 from 16 MAF to 12 MAF. The population of Pakistan has since more than doubled. The IBIS includes 3 main storage reservoirs, 20 barrages, 12 Inter River Link Canals, 43 Canal Commands over 20,000 public tubewells and around 1,000,000 private tubewells. Some 120,000 watercourses and a huge surface and sub-surface drainage system. Agrarian economies should aim at a strategic one year surface flow in their reservoirs. India will soon achieve 40%. Pakistan has not even been able to maintain a ten percent (10%) reservoir capacity. The nation that has great strategic hydro resources in the Himalayan and Karakorum glaciers is heading surely towards famine conditions as it fails to store more water and replace the reservoir capacity already lost. *Some political elements continue to ignore the basic fact that it is floodwaters during monsoon months that will be stored and utilized during the remaining ten months.*

16.5.6 **Today the Indus Waters Treaty (IWT) is projected to be controversial:** Pakistan's military and political leaderships had not shown the resolve after the breakup of Pakistan in 1971 to force the truth on the Nation. While the Indian factor motivates internal opposition (specifically from regional politicians) to new dams on the Indus she quotes international law on rights of the upper riparian when the lower riparian fails to fully utilize sweet water flows for a 30 years period. India ignores that the IWT is sacrosanct and till eternity. *Our leadership and our nation has not understood the value of water.*TheIndians do.

Pakistan never exceeded 13% storage capacity of its surface flows. We assume an annual surface flow of the Indus and its associated rivers to be 145MAF. India has surface flows of around 750MAF on an annual basis. Their cumulative storage capacity by 2003 was 245MAF and growing fast. They had already achieved more than 32% storage capacity. The world average is 40% storage capacity of surface flows. An ideal situation would be storage capacity close to 100% so that maximum carry over capacity is available for years of drought. The table below will further clarify this point.

Average Annual Flow and Storage Capacity of Dams of some major river basins

S. No.	River Basin	Average annual flow (MAF)	No. of Dams	Storage capacity (MAF)	% age storage
1	Nile	38	1	132.00	347
2	India (Total)	750	4636	245	32.6
3	Indus and other rivers	145	3	13.64	9
4	World	20000	-	8000	40

Source: Medium Term Development Framework for water sector (Group report) World Register of Dams 2003-ICOLD (Courtesy Mr. Amjad Agha Nov. 2005)

16.5.7 **The 1991 Water Accord permits about 22 MAF new storages:** One third of this would be replacement of capacity lost. It assumes that 38 MAF of monsoon flood waters on average flow into the Arabian Sea every year. It was a prosperity document for all four provinces but has been willfully made controversial. Punjab made major sacrifices in agreeing to take far less than its due share from the new resources. The Accord eliminated the concept of Historical Withdrawals of Indus waters. Logically it had to cater to the new geographical realities eg: Sind was much larger before partition. By year 2010 atleast 11 MAF new surface storage was required of which half was to be replacement storage as the existing reservoirs continue to receive sand silt and sediment at the rate of 165 mn tons per year in the Indus River alone. Without new storages the Accord would have hardly any value and use. The status quo option is one of looming famine conditions also for the children of Sindh. Sindh with its saline and brackish underground water depends only on surface sweet water supplies and cannot have aquifer

pumping as in Punjab. Sindh therefore needs canal and distributory brick lining as it cannot afford seepage due to its saline aquifer. Punjab does not urgently need brick lining of its water courses. Its canal seepage is partly recovered with the precious aquifer resources but underground water quality is becoming an issue in parts of Punjab. The high cost of lining in an inhibitor.

Sindh objections are that there is not enough water in the Indus basin and WAPDA may not create further reservoirs on the Indus main stem. This is a very tragic position since ISO 14000 studies carried out by the World Bank in 1987 prove that 35MAF flow downstream of Kotri is not necessary for the mangroves and ecosystems. This had made the 1991 Water Accord possible between the four provinces. Sindh was the biggest beneficiary as it would receive 37% share of all new reservoirs the same as populous Punjab. Incidentally KBD would only store 6MAF while Daimer Basha would store around 5MAF. This would make flows in the Indus main stem more regulated during all 12 months instead of unregulated high flow during the monsoon months and very low flows during the winter and spring months. The feudals of Sind are basically interested in flooding a swath about 14 km wide of riverine (katcha area) on both sides of the Indus river. Basically it is irrigation of 0.7 million acres by moisture (sub-irrigation through salaba / flooding). This is a great waste of resources and not in the long-term interest of the people of Sindh. The wadera feudals have to be convinced first or ignored!

16.5.8 **NWFP objections were based on the 1929 flooding of Nowshera valley:** This historical flood occurred when the Swat Kabul and Indus rivers were in extreme high flow due to non-stop rainfall in their catchment areas. There were no means of telecommunication and no telemetry/automatic stations to give an advance warning to the authorities to expect a flood at Nowshera due to the back pressure from the constricted Attock gorge. British bombers were flown from England and they had to fly reconnaissance missions before they discovered that nonstop rain and total absence of telecommunications has caused this situation. Today there are multiple arrangements for over 2 weeks advance warning of a coming flood. The availability of a dam permits immediate draw-down of the reservoir to take the flood shock. Dams are flood control devices and do not induce floods. Only KBD allows gravity flow to the right bank and would permit the 14% share to NWFP under the 1991 Water Accord. The natural drainages of Peshawar Kohat and Nowshera valleys will not be affected by KBD. Water finds its own level. Similarly the maximum level of KBD reservoir during the flood season will be 915ft above sea level. The lowest point in the Peshawar Kohat and Nowshera valleys is Pabbi 962ft. There is no known scientific reason (including capillary action) for water logging to happen. Neither can natural drainages of the NWFP valleys be affected due to KBD. The 2010 floods created greater havoc (compared to 1929) but again the KBD did not exist.

16.5.9 **Bhasha Dam was unfortunately made the focus of attention by former Chairman WAPDA in July 2001 during the launch of WAPDA Vision 2025:** This was an error of judgment as National Conference of 09 Feb 1998 based on rational data had concluded that Bhasha is above all a debris-check dam for enhancement of Tarbela Dam's useful life. Conceived as a roller compacted concrete gravity dam about 232m above riverbed and about 281m above bedrock it dwarfs even the Grand Coulee. No doubt it will add around 5MAF reservoir capacity and cheap hydropower during its short life span but its construction is a monumental task which could involve upto 15 years. Several major constraints in building Bhasha are well known. The KKH from Thakot upto site (over 200 km) has to be strengthened/widened. This is an arduous task. There are absolutely no construction materials at dam site (only granite). The upstream KKH around 100 km has to be rebuilt at a higher alignment (about 900 ft higher). There are strong lifting pressures due to soil conditions of the riverbed. After all we are attempting to construct the highest ever light structure Roller Compacted Concrete (RCC) dam in the world. Higher than Hoover Dam! No rock or earth filled base. The dams downstream terrain has a climb elevation of 1:7 which is excessive for operation of heavy construction machines. Finally it is an active seismic zone of the Karakorums where the Indian and Central Asian plates meet. The ongoing design is theoretically beyond todays knowledge of dam building technology. Let us keep in mind the Pattan earthquake of the 70s, the October 2005 earthquake and the May 2003 Sichuan earthquake. If this dam

breaks it will leave nothing in its path upto Sukkur. Late Lt. Gen. Dr. G. S. Butt's three letters of 2004 to the President of Pakistan. Refer at Chapter-13.

16.5.10 Appointment in 2004 of Mr. A.N.G. Abbasi as head of the so called "Technical Committee" on the advice of Senator Mr. Nisar Memon:

Both ANG Abbasi and Mr. Nisar Memon had written a controversial Water Committee paper in 2000. In 2005 he delayed his report compelling the other 7 members to submit their report independently of him in May 2005 while he took several months longer. He however ensured that Bhasha takes precedence over Kala Bagh Dam (KBD) and recommended it to be a carryover dam without canals. Bhasha can have no canals for KP and Punjab. KBD is a never silting dam with 6.1 MAF live storage. Although smaller than Tarbela its location is near perfect. Maximum flow of the Indus river(within highlands) occurs at KBD site as glacier waters and monsoon waters converge. KBD has to be operated in conjunction with its bigger brother Tarbela and smaller brother Bhasha for best results. Dams in cascade allow release-hold sequence whereby the same water quantity is used repeatedly for power generation and the required irrigation releases are from optimum locations. Are we going to remain at around 20 million tons wheat production forever? In March 98 Mr. Gupta of the World Bank visited me in the company of Dr. G.S. Butt and Mr. Khalid Mohtadullah (then member Water WAPDA) and related the saga of KBDs very extensive studies. It was reassuring to learn that ISO-14000 studies were also done in 1987 which removed doubts about any negative environmental impact. The propaganda about sea-water intrusion destruction of mangrove forests in the Indus delta as well as impact on fisheries have all been thoroughly investigated. KBD is indispensable for Pakistan's economy. The 4 April 97 letter of World Bank President Mr. James Wolfensohn recommends KBD as part of the least cost solution and a project which could add significantly to Pakistan's irrigation potential. Dams help to control floods and do not induce them. The nation has not appreciated the role of water reservoirs in the national economy. Some are playing politics and blocking projects for sweet water storage under the tragic slogan of provincialism. WAPDA which used to give rupee loans to the GoP in the 1970s was burdened with excessive electrification by successive governments but was denied after 1974 the indispensable multipurpose reservoirs. The Hydel policy 95 (a ministerial decision) and the National Drainage Policy 1997 have been bad precedents. Severe imbalance of irrigation and drainage has particularly created more water logging and destruction of irrigated agriculture. The ominous Indian factor is clearly visible.

16.5.11 **It becomes important for us to calculate the financial impact of 1 MAF of additional reservoir capacity in the IBIS:** I am convinced it is now around USD two billion per annum on the nations GDP. KBD construction should have commenced in 1983/84 and completed in 1992/93. Therefore in the 21 years that KBD could have been available the loss to the national economy due to the 7MAF KBD alone has been over USD 230 Bn. Infact the non-implementation of the 91 Accord means that after year 2000 we lose cumulatively around USD 44 Bn per year. It is simple to check this thesis. Remove Tarbela (9 MAF reservoir and power generation) from the scene and Pakistans economy will shrink by 15% to 20% at todays GDP level besides other implications. *Remember the 1991 Accord allowed 22 MAF additional storages half toaugment & also replace the lost capacity of existing reservoirs.*

16.5.12 **The entire developing world is building dams. Indian activity is suspect:** China has completed several thousands in recent years (total now around 22000) including the Three Gorges Dam. The USA built 5500 dams and does not need more. It can afford to decommission some. India has undertaken 650 dam projects (over 4000 exist) including the controversial NIRMADA after the Indian Supreme Court decreed it. *India has launched in 2006 the USD 212 Bn Northern Reservoirs Linking project whereby in ten years all reservoirs from East Punjab to Bengal would be interlinked. It is the world's largest ongoing irrigation project.* This astounding project based on the Prabhu Task Force Report is also known as the river linking project. A network of link canals to connect all the rivers of India; Mahanadi to Godavari Krishna to Godavari Brahmaputra to Ganga Narmada to Tapi Cauvery to Vaigai.

16.5.13 **WAPDA as predicted is now unable to undertake major projects on its own balance sheet:** A major handicap for the sustenance of the IBIS. The hydro based TVA model has been mutilated. Pakistan has become a water short country. Fresh rounds of thermal IPPs are now being permitted creating a mortally dangerous situation. The tariffs are unsustainable for the economy. Competition with public sector is not even discussed; such is our anxiety for FDI. The final blow could come with privatization of dams.

16.5.14 **Food Autarky:** The IGC (International Grain Council) gave its first caution in August 1997 when Chinas wheat production fell from 127mn tons to 104mn tons the year earlier. Fortunately the wheat production of the year 1997/98 did not fall from the total 586mn tons level of the previous year. That year only 94mn tons were available for world trade in wheat but the total stocks held were an adequate 103mn tons. Thanks to global warming crop failures drought and changes in crop patterns in Australia, Canada and USA and partly due to the use of crops for producing ethanol and biodiesel we see a crisis developing. The IGC estimate for 2005 showed that the peak in wheat production has been crossed and it was now downhill. Please note that the world wheat production in 2005/06 was 620mn tons but it declined to 590mn tons in 2006/07. The consumption is estimated at 610mn tons. A shortfall of 20mn tons which is a serious depletion of world stocks! Prices for this reason have risen three times in last 5 years. Prices doubled to USD 400 per ton in Jan 2008 from USD 208 in January 2007. The price situation with Coarse Grains such as maize millet and sorghum is not critical.

16.5.15 **Sadly in the last five years we see severe shortage of electric power develop in the country:** Electricity deficit during March 2014 was approx 5,000MW in a total Generation capacity of 20,000MW (WAPDA KESC IPPs Captive power and PAEC). Regretfully the mix has been made lopsided. Instead of the hydel: Thermal ratio of 70:30 outlined by the national planners;it is now around 33:67. Thermal energy includes Nuclear energy generated by PAEC. Regretfully generation based on coal is negligible. Our 184 Bn tons of brown coal (lignite) reserves at Thar discussed since 40 years after the first serious report established its huge potential. We wish SECMC great success in its 2x330 MW That lignite based TPS.

Construction of Kalabagh Dam should have commenced in 1983-84. Education and infrastructure were already neglected areas since 1971. In May 2000 the Pakistan finance delegation to Beijing under Finance Minister Shaukat Aziz participated in the fifteenth Inter-ministerial Conference and basically received the roll-over of the USD 500 mn of PRC funds which constituted the bulk of the Pak foreign currency reserves! Bankruptcy loomed before 11 Sep 2001 and the start of the war on terror. Dollars flowed in as aid &loans were rescheduled or converted to grants etc. Private capital also returned home. The relief is not permanent. In 2007 Pakistans energy import bill for 17.5 mn tons of petroleum products including HFO/RFO crossed USD 11 Bn and the budget deficit crossed USD 10 Bn!

16.5.16 **India's genocidal war through water theft:** The foregoing analysis confirms that we are since 1947 being subjected to a life and death struggle by India the upper riparian. India's war has been surreptitious. The role of the Americans at the incipient sages of the nascent dispute has been humane and statesmen-like. The brilliant article of Mr. David E. Lilienthal as reported on 4 Aug 1951 having the title ANOTHER KOREA IN THE MAKING was attached to the letter sent by IBRD (World Bank) president Mr. Eugene R. Black on 6 Sep 1951 to the Prime Minister Mr. Liaqat Ali Khan. The IBRD initiative was benign and timely. The subsequent events leading upto the signing of the 19 Sep 1960 Indus Waters Treaty at Karachi between P.M Mr. Jawaharlal Nehru and President Ayub Khan are well recorded in Mr. Bashir A. Maliks book Indus Waters Treaty in Retrospect. The IBRD acted as Facilitator and Guarantor for the Treaty. However the Indian mindset and machinations were beyond the comprehension of people acting as honest and concerned brokers in this deadly water game. The Indian effort has been so comprehensive and total that it can only be described as war for water which is leading to a genocidal phase for the loser. Regretfully Pakistan is at the receiving end. Who is motivating and financing this vicious and dangerous enterprise against the people of Pakistan?

16.5.17 **The mix of incompetence institutional greed and nations lost opportunities:** Scientific thought and discipline are not in style here. The Poverty cycle could not be broken here especially due to the fact that the political leadership was generally looking for short-term gains. The bureaucrats are part of the problem. For every efficient and patriotic bureaucrat there is someone who is working on a personal agenda. The failure to build multi-purpose dam projects on the Indus main stem after 1974 (Tarbela) is perhaps the biggest economic catastrophe in our history. Let us look at some recent examples where impulsive and arbitrary decisions resulted in major setbacks to the nation.

In Dec 2001 during the second visit of President Musharraf to PRC several MOUs were signed for run of the river power projects with various PRC engineering and construction companies on a turnkey (EPC) basis. *WAPDA had invited renowned PRC corps to assist Pakistan to take a leap forward within the objectives of the VISION 2025 program launched in July 2001.* The invitations were sent in Nov 2001 inviting PRC groups to agree to sign hydropower MOUs in the presence of the President of Pakistan who was to make a state visit in third week of Dec 01. Within the MOU draft each PRC supplier/contractor received a reference price for the EPC (turnkey) project for which suppliers credit was to be arranged by the individual supplier/contractor. Therefore WAPDA solicited and invited partners. The author of this hydel campaign known as WAPDA VISION 2025 and launched in July 2001 was Lt. General (Retd) Rao Zulfiqar Khan a clean hardworking Chairman of WAPDA since late 1998. His quirk being that he was somewhat distrustful of contractors of all shades. The PRC groups showed exemplary cooperation. Only one MOU for the 96MW low head Jinnah Hydel on the Jinnah Barrage became a contract with M/s. Dongfang in Nov 2003. The cost allowed +USD128 m. The PRC Exim credit at reduced 5% interest p.a. The power station has a high plant factor as it utilizes part of the main Indus flow at Jinnah Barrage.

Three other Hydropower MOUs were signed in Dec 2001 in the presence of the President. With M/s. Sinohydro Group for Golen Gol 106MW (Upper Chitral) CMEC Group for several low head canal based P.S. in Punjab (totaling around 80MW) and with CGGC/Gezhouba Group for Keyal Khwar 130MW (Kohistan).they were later dropped by GOP inspite of the fact thatthe high head Keyal Khwar project was offered at a cost of USD100mn on turnkey/EPC basis. The MW cost as a fixed / non-escalable of USD 0.72mn per installed MW. WAPDA explained in January 2004 after rejection by ECNEC that it was due to the KP Authorities interference. Today the same project is being constructed at a cost of around USD 2 mn per MW with KFW financing.*A small but significant initiative to start exploiting the +85,000 MW hydropower potential which our nation had identified. Indeed future generations will be unable to understand why we could not find a quicker way to use this hydel potential known to us since 1960s.?*More IPPs must come forward if WAPDA or the provinces are not interested to develop raw sites etc.

16.5.18 **PPIB (Private power and Infrastructure Board Islamabad):**Since its creation in the early 1990s this organization has been used firstly as a project office of the Federal Ministry and as a convenient bypass of WAPDA. The official objective being very noble i.e: to provide a one-window facility to Investors from the Private sector. They have offered two rounds of hydel IPPs in the last 3 years. Several investors came forward for projects in the 50MW to 800 MW range. There is the usual constraints, geological site risk and hydro flow site risk factors. The recent entryinto the Pak-China Economic Corridor of some major HPP projects on the Jhelum (both AJK & Punjab) as well as in Hazara, KP is a great boost.

16.5.19 **A symphony of facts concerning irrigation and power sectors:**The water use has grown at more than twice the rate of the population increase during the 20th century. **Please note:**

i. *WAPDA* became the chain of the federation by harnessing the resources of the Indus basin irrigation waters. It represents around 20% of the national asset base of Pakistan and is effectively the backbone of the economy. It has been a welfare utility based on the most successful TVA model of USA. Its distribution assets should have reverted to the provinces under the 1973 Constitution. The provinces could decide the fate of the Discos (Distribution

coys) so that the federation is not damaged. WAPDAs balance sheet has been made weak because the devolution was too rapid. Can it build large multi-purpose projects needed for survival of Pakistan's irrigated agriculture? The food black-hole around USD 1 bn and the energy black-hole of around USD 4 bn pa would be ever expanding. Secondly WAPDA is the largest sustainer of the local engineering industry and generally low cost energy is the second pillar of industrialization. WAPDAs situation has already affected 25,000 technicians the most serious human resource crisis since the Bangladesh debacle. The best have left the country. Corruption has increased.

ii. *WAPDA revised Mangla Dam* height by 45ft and hopes an additional 3 MAF would be available for irrigation. Studies have shown that this premise is not correct. Except during abnormal floods this additional water would not be available. The studies show that during six years in ten the raised dam would not fill. We spent US$900 mn (PKR90 billion) or more when the advantage would occur every seventh year.

iii. *Breaking the poverty cycle* has been the goal now for 50 years. The engineers as a group are agitating for use of our plentiful indigenous resources. The Kalabagh Dam (KBD) for example could generate 12000 GWh (12 billion units) per year. Through irrigation benefits KBD could pay back its entire cost in one year. Besides KBD would be a replacement reservoir to Tarbela and both would work more efficiently in cascade. Does any politician have a solution if there is liquefaction of sediment delta (standing few km north of Tarbela Dam) due to seismic activity?

iv. *Please remember WAPDA had surpluses before 1995* and would periodically give loans to the GoP and self-finance the local component. WAPDA could not become financially more dynamic as it had to finance a callous rural electric network expansion for 28 years. The influentials and regional subsidies denuded WAPDA and not the usual corruption by its low paid line staff. The utility function of power distribution billing and collection was never intended to be part of the original WAPDA charter.

v. *WAPDA has indeed become the chain of the federation* because it supplies the bulk the irrigation water to the provincial irrigation departments and has developed an equally successful national High Voltage grid system which receives power from its dam based hydel power stations in the north and its thermal power stations in the central and southern locations. By harnessing the resources of mother Indus WAPDA has become the chain of the federation. The ideal Hydel-Thermal energy ratio of 70:30 has to be pursued. Our long term salvation is indigenous energy both hydro &lignite.

vi. *WAPDA*be made viable: It has to realize the potential through water storages built on a war footing to augment its irrigation &power systems. At least four new storages have to be built in the next years. Together with the identified HPPs on the Indus Main will allow in 25 years about 29,000 MW (104,400GWh energy p.a)of Sasti Bijli as part of the Indus Cascade (2015-2040) and help make Pakistan a powerful state.

16.6 Conclusion:

WAPDA the economic backbone of Pakistan has to be made viable. A technocrat from the civil or military hierarchy must be inducted to stop the rot. The intelligentsia must play its role in building public awareness on the "Greater Kashmir" game which has blocked our mega projects. **KBD is a quick & economical lifeline for Pakistan and has to be built at all costs as part of The Great Indus Cascade (2015 – 2040).** Its perfect location for both irrigation,flood control & energy production are indisputable. Imported oil based thermal PS have to be inhibited and NEPRA must assist in offering then incentives to convert to coal firing. The primary energy consumption which includes hydro, nuclear,

coal, oil & gas was 65.8m tons in 2011. Reject all previous plans and reduce imported oil in real terms by 5% annually from its peak of 24m tons of which +12m tons is RFO for IPPs and some for public sector generation. Oil consumption may remain static at 425,000 barrels/day (58,219 tons/day). Pakistan's reduced hydro storage capacity is about 8% of its annual surface flows of 145MAF. Pakistan needs water for its agricultural and energy needs. Substitution by imported energy (oil) is not sustainable in the long term. The national objective has to be an average annual increase of 12% in the surface storages for the next 15 years and within these years to achieve the desired Hydel:Thermal ratio of 70:30 from Hydro Reservoirs & Run-of-River HPP. In fact whichever part of Pakistan will be denied Indus Waters its economic growth will be nearly impossible & extremism will follow. CIBSA (Commission of Indus Basin Strategic Analysis) be established. Indians created ICID in 1950 & today we have to face this monster without the tools. PCIW & IRSA are toothless organizations unable to neutralize the machinations of the ICID network. WAPDA must be again given a pivotal role in the strengthening of PCIW as per the practicebefore 1988. The public private partnership may be encouraged for raw hydel sites. The Great Indus Cascade (2015 – 2040) is detailed at Annexure-F.

Three historical documents are appended. The first is "Indus River Development Prospects" proposed in 1990 by Dr. Hon. Shams ul Mullk at Appendix II. At Appendix III the KBD and DBD comparison in 1987 was based on the MONENCO studies. Experts are convinced that everything that followed i.e: opposition to KBD and the cynical & dangerous increase of DBD;height in 2004 by the NEAC JV and the subsequent change of its alignment by the Lahmeyer Consortium during its detailed design phase in 2006/07 are "Pakistan's politics of water." In retrospect it seems more like the enemy's agenda.

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Appendix-I

'Neelum-Jhelum Project cost increases four times'

By Our Correspondent
LAHORE

THE cost of Neelum-Jhelum Hydropower Project has seen nearly four-time increase since 2001 and this vital hydel power generation project has yet to be completed.

According to a Wapda spokesman, as per Revised PC-1 of Neelum-Jhelum Hydropower Project, the cost of project now projected at Rs. 416 billion from initial estimate of Rs 84.55 billion showing a mammoth jump of 392 percent.

To reassess cost of the project, a meeting of Pakistan Water and Power Development Authority (Wapda) was held at the Wapda House on Tuesday, which was presided over by Chairman Wapda Zafar Mahmood.

While reviewing the revised PC-1 for 969-MW Neelum-Jhelum Hydropower Project before sending it to the Ministry for Water and Power, the meeting deliberated upon factors responsible for the cost escalation of the project. It was noted that right from the beginning, the basic project concept went through major changes. Initially the project was designed for 550 MW capacity with a Power House situated at Majhoi. However, subsequently, to optimise power generation from this project the Power House was shifted to Chattar Kalas, 21 km west of Muzaffarabad. This change resulted in additional financial implication.

The meeting further noted the 1st Revised PC-I approved by ECNEC in 2002 for Rs. 84.55 billion was based on 2001 price level. At that time, the work on the project could not start due to lack of upfront funds. The funds were made available in 2007 and the contract work was awarded the same year. The amount of awarded contract was Rs. 90.90 billion and was one of the reasons of increase in the overall cost of the project. It was further discussed that in the aftermath of devastating Earthquake of October 08, 2005, the project consultants, as a part of their assignment, reviewed tender design and undertook additional studies and investigations. The design review identified many areas of concern requiring design changes, which resulted in increased quantities and additional scope of work with substantial financial implication.

The major design changes which form the huge chunk of this additional cost include change in the height and design of the dam, composite concrete embankment to cope with the fault movement, increase in cross sectional area of headrace tunnel, concrete lining of tunnels, steel lining in the tunnel under Jhelum River, class 70 bridge on Neelum River and other additional works required for implementation of the project. In addition, two Tunnel Boring Machines (TBM's) have been deployed for excavation of

Continued on page 19

Neelum-Jhelum

Continued from page 13

most critical reach of 11.5 km of twin tunnels (total length 23 Km) as acceleration measure.

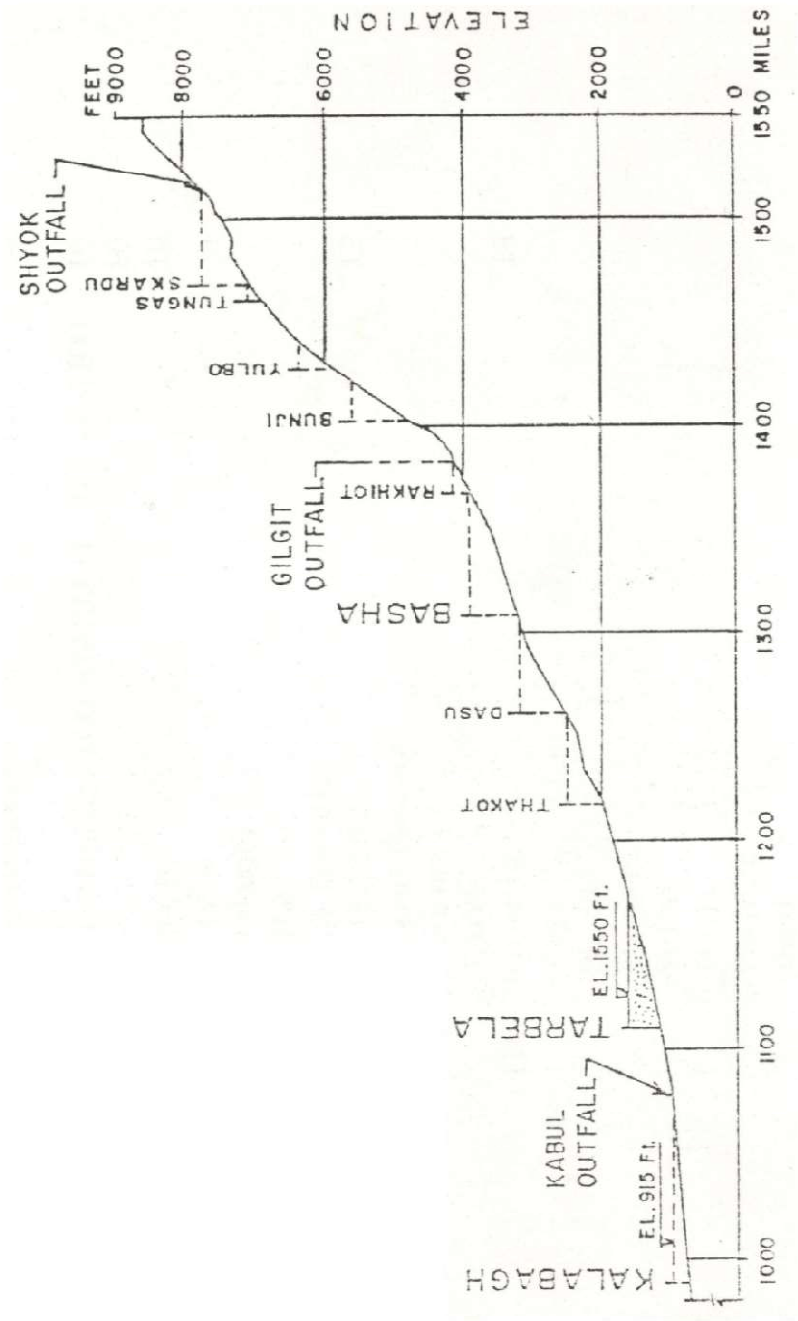
Three diesel generators with 4MW capacity each were also procured for uninterrupted power supply. There was no provision for payment of escalation in the previously approved PC-1 which had very high financial implication. Variation in Dollar Exchange Rate and security arrangements also inflicted heavy additional financial burden.

The meeting noted with great concern that revised PC-1 of the project, amounting to Rs. 274 billion, was approved in 2012 with artificially depressed price without giving due consideration to potential harm which could hamper its scheduled completion.

In the following table the increase in major component has been brought out which clearly shows that increase in the cost of civil work is of minor nature. The items, which have shown increase, were intentionally not fully catered for (Rs. Million) S. No. Item PC-I (2012) PC-I (2015) Increasel Total Construction Cost 162,848.00 165,266.002,418.002 Engineering & Supervision 8,967.0016,343.007,376.003 Exchange Loss 37,269.0074,119.00 36,850.004 Duty and Taxes 1,519.00 12,396.00 10,877.005 Price Escalation17,847.00 61,933.00 44,086.006 Interest during Construction 33,438.00 61,548.00 28,110.007 Others 15,615.00 24,881.00 9,266.00 Total 277,503.00 416,486.00 138,983.00. The Authority maintained that the cost of works of Neelum-Jhelum Hydropower Project remained the same but the abovementioned factors had necessitated another cost revision of the project. The meeting decided to send a revised PC-1 of Rs. 416 billion to the Ministry of Water and Power for its on-

Appendix-II

INDUS RIVER DEVELOPMENT PROSPECTS



Shams ul Mulk, Member (Water) WAPDA (February 1990)

Appendix-III

KALABAGH DAM AND BASHA DAM (1987)

FEATURE	KALABAGH	BASHA
1. Reservoir		
- Live Capacity	6.1 MAF	5.7 MAF
- Power Installation	3600 MW	3360 MW
2. Main Dam		
- Max height above river bed	**260 ft**	**660 ft**
- Under – seepage control	Positive cutoff – well tried technology	Reinforced concrete diaphragm wall – unprecedented for the hydraulic head 850 ft, border line technology
3. Access		
- Roll head	8 miles from dam site	175 miles from dam site
- Road	Normal up-gradation of road	Upgrading and widening of KKH From Manshera upto Chilas (177 miles with 50 bridges)
4. Seismicity	Comparatively low	Highly seismic zone
5. Field explorations & studies Drilling / boring (effective)	Extensive (70,000 ft)	Inadequate (12,537 ft)
6. Power House	Above ground	Underground
7. Current (1987) project status	Ready for implementation	Detailed investigations and design requires 6 to 8 years

17. WATER & ENVIRONMENT: WASTEWATER PRODUCTION, TREATMENT AND USE IN PAKISTAN

Ghulam Murtaza, Munir H. Zia (University of Agriculture, Faisalabad)

17.1 Abstract:

Pakistan, once a water-surplus country, is now a water deficit country. The water availability has decreased from more than 3000 m^3 per capita in 1947 to 1,299 m^3 in 1996-97 to 1,100 m^3 per capita in 2006 and it is projected to be less than 700 m^3 per capita by 2025. Therefore, search for other non-conventional water resources for irrigation i.e. use of wastewater through proper treatment, has become important. In Pakistan, domestic and industrial wastewater is either discharged directly to a sewer system, a natural drain or water body, a nearby field or an internal septic tank. Mostly, this wastewater is not treated and none of the cities have any biological treatment process except Islamabad and Karachi, and even these cities treat only a small proportion (<8%) of their wastewater before disposal. The wastewater used for irrigation is valued by farmers, mainly because of its nutrient contents and reliability of supply and exert positive impacts on agriculture land values, households, monthly income and employment due to reuse of wastewater despite the ill effects of wastewater irrigation on soil's physical and chemical properties in addition to contamination of human food chain and related health risks. Limited information is available in this regard. There seems no national policy in effect on sustainable use of wastewater in this country. Problems of wastewater disposal tend to stem from distortions due to economy-wide policies, failure of targeted environmental policies and institutional failures. Thus laws and regulations have been formulated about treatment and disposal of wastewater but their implementation due to lack of resources and skilled manpower is the real issue. There is hardly any well organized study which focused on risk assessment in a systematic way. Some of the systematic work has been done by IWMI and Pak-EPA with financial aid from foreign donors. Therefore, a well-coordinated program is necessary to create awareness among different sections of the society including the general public, organizations, industrialists and farmers.

17.2 Water availability and use:

Pakistan has become a water deficit country due to depleting ground and surface water resources, loss in surface shortage, prevailing droughts and shift of fresh water from agriculture to more pressing domestic as well as industrial uses (Ensink et al., 2004). Under the existing conditions renewable water resources - both rainfall and river flows are estimated to be around 400 BCM – with variations depending upon the climatic conditions. Overall water availability has decreased from around 3,000 cubic meters (m^3) per capita in 1947 to 1,299 (m^3) in 1996-97 and 1,100 m^3 per capita in 2006. It is projected that water availability will be less than 700 m^3 per capita by 2025 against the international standard of 1500 m^3 per capita (Pak-SCEA 2006). Therefore, search for other nonconventional water resources for irrigation i.e. wastewater has become important.

Surface Water: The recent statistical data shows that the Indus System and its tributaries provide an average 170 billion cubic meters (BCM) or 142 MAF of water annually of which nearly:

- 115 BCM (96 MAF) is utilized for irrigation;
- 43 BCM (36 MAF) flows to sea; and

- About 12 BCM (10 MAF) is consumed by the system losses which include seepage, evaporation and spill during floods

Groundwater: Groundwater resources are estimated around 55 BCM/ year (about 40.5 MAF), of which around 96 % is used for agriculture and the remaining for domestic and industrial purposes. Recharge to groundwater is mainly from rainfall, irrigation system and the rivers during high flow seasons.

Need of the day: Keeping in view the ever increasing demographic pressure and development in the industrial sector, Pakistan would need more additional water in future to meet irrigation and other requirements of the people. This would not possible unless:

- New storage dams are constructed; and
- Attention is paid on appropriate re-use of wastewater.

17.3 Wastewater production and treatment:

17.3.1 Wastewater Production

Latest estimates reveal (PWSS, 2002 & Table-1) that total quantity of wastewater - produced in Pakistan - is around 962,335 million gallons (4.37 BCM/yr) including 674,009 million gallons (3.06 BCM/yr) from municipal and 288,326 million gallons (1.31 BCM/yr) from industrial use. A recent survey indicates total wastewater as 5.54 BCM/yr for the year 2011).

The total wastewater discharged to the major rivers is 392,511 million gallons (1.78 BCM/yr and 1/3rd of all wastewater), which includes 316,740 million gallons (1.44 BCM/yr) of municipal and 75,771 million gallons (0.34 BCM /yr) of industrial effluents. Petrochemicals, paper and pulp, food processing, tanneries, refineries, textile and sugar industries are major industrial contributors to wastewater pollution in Pakistan (UNIDO, 2000). It has also been estimated that around 2,000 million gallons of sewage is being discharged to local surface water bodies every day (Pak-SCEA 2006). The industrial sub-sectors of paper and board, sugar, textile, cement, polyester yarn, and fertilizer produce more than 80% of the total industrial effluents (WB-CWRAS Paper 3, 2005). Based on the study by WWF sector-wise availability of wastewater is shown in Table-1 given below:

Table 1: Sector wise estimated wastewater production in Pakistan

Sr. No.	Source	Volume	
		10^6 m^5 y^{-1}	Percent %
1	Industry	395	6
2	Commercial	266	5
3	Urban Residential	1,628	25
4	Rural Residential	3,059	48
5	Agriculture	1,036	16
	Total	**6,414**	**100**

Source: Pakistan's Wetlands Action Plan, 2000, prepared by NNCW and WWF

17.3.2 Wastewater Treatment

In Pakistan, domestic wastewater containing household effluent and human waste is either discharged directly to a sewer system, a natural drain or water body, a nearby field or an internal septic tank. Normally, municipal wastewater is not subjected to any treatment and none of the cities have any biological treatment process except Islamabad and Karachi, and even these cities treat only a small proportion of their wastewater before disposal. Assuming that all the installed treatment plants are working at their full installed capacity, it is estimated that about 8% of urban wastewater is probably treated in municipal treatment plants (Table 2). Other estimates suggest that the figure is not greater than 1 per cent. The treated wastewater generally flows into open drains, and there are no provisions for reuse of the treated wastewater for agriculture or other municipal uses. Table-2 shows ten large urban districts of the country, which produce more than 60% of the total urban wastewater including household, industrial and commercial wastewater (WB-CWRAS Paper 3, 2005). A negligible proportion i.e. 8% of wastewater in Pakistan is treated through sedimentation ponds to a primary level only but most of the treatment plants are not functional therefore the figure can be estimated around 1 per cent. There is no prevailing concept of treatment at secondary and tertiary level in this country. Although treatment facilities exist in about a dozen major cities, in some cases these have been built without the completion of associated sewerage networks, and the plants are often either under-loaded or abandoned (Pak-SCEA, 2006).

Table 2: Wastewater Produced Annually by Cities (WB-CWRAS Paper 3, 2005)

City	Urban Population (1998 census)	Total wastewater produced ($10^6 m^3/y$)	% of Total	% of Trreated	Receiving Water Body
Lahore	5,143,495	287	12.5	0.01	River Ravi, irrigation canals, vegetable farms
Faisalabad	2,008,861	129	5.6	25.6	River Ravi, River Chenab and vegetable farms
Gujranwala	1,132,509	71	3.1	-	SCARP drains, vegetable farms
Rawalpindi	1,409768	40	1.8	-	River Soan and vegetable farms
Sheikhupura	870,110	15	0.7	-	SCARP drains
Multan	1,197,384	66	2.9	-	River Chenab, irrigation canals and farms
Sialkot	713,552	19	0.8	-	River Ravi, irrigation canals and farms
Karachi	9,339,023	604	26.3	15.9	Arabian Sea
Hyderabad	1,166,894	51	2.2	34.0	River Indus, irrigation canals and SCARP drains
Peshawar	982,816	52	2.3	36.2	Kabul River
Other	19,475,588	967	41.8	0.7	
Total Urban	**43,440,000**	**2.301**	**100.0**	**7.7**	

Source: Master Plan for Urban Wastewater (Municipal and Industrial) Treatment Facilities in Pakistan. Final Report, Lahore: Engineering, Planning and Management Consultants, 2002

Existing Scenario: The problem of industrial water pollution has remained uncontrolled because there have seen little or no incentives for industry to treat their effluents (WWF, 2007) – as discussed below:

- In KP, 0.71 BCM/yr of industrial effluents containing a high level of pollutants are discharged into the River Kabul (SOE, 2005).

- In Sindh province, only two sugar mills (out of 34) have installed mechanisms for wastewater treatment mainly because of international pressure as these industries (distilleries) export their products (SOE, 2005). With an exception to fertilizer sector (UNIDO, 2000) which invested significantly in installing wastewater discharge treatment plants; throughout Pakistan the industrial approach towards environment is very discouraging.

- In Lahore, a major city of Punjab province, only 3 out of some 100 industries using hazardous chemicals treat their wastewater.

- The situation is even worse in Sindh Province, for example, in Karachi, Industrial Trading Estate (SITE) and Korangi Industrial and Trading Estate (KITE), two of the biggest industrial estates in Pakistan, there is no effluent treatment plant.

- In Karachi for example, a city that accommodates 70% of Pakistan's industry, approximately 70% of wastewater, (i.e., > 0.242 BCM/yr) reaches the Arabian Sea without any form of treatment. Among the industries established in the industrial zone of Karachi, 16% comes in the more polluting category while 59% can be classed in the somewhat polluting category. Only a portion of the generated industrial effluent (≈0.035 BCM/yr) from this zone goes to a Treatment Plant (TP1) and this treatment plant is only working at half of its capacity, because of the inadequate sewage piping system.

Moreover, the NEQS prescribed by the Environmental Protection Agency of Pakistan are primarily concentration based. Unfortunately, limits on liquid industrial effluents are neither industry-specific nor do they have any relationship with the quantum of production. The NEQS prohibits dilution, but this can be easily circumvented (UNIDO, 2000).

As per a review of literature, out of 388 cities of Pakistan, only 8 have wastewater treatment facilities, that too up to primary level. According to the Pakistan Water Situational Analysis, there are three wastewater treatment plants in Islamabad, of which only one is functional. Karachi has two trickling filters, where effluents generally receive screening and sedimentation. Lahore has some screening and grit removal systems, but they are hardly functional. In Faisalabad, there is a wastewater treatment plant, in which wastewater receives primary treatment. In rural areas, wastewater treatment is nonexistent, leading to pollution of surface and groundwater.

17.4 Wastewater use/disposal:

Urban centers are the main cause of water pollution in this country. Typically, storm water drains and nullahs collect and carry untreated sewage which then flows into streams, rivers and irrigation canals. Although there are some sewerage collection systems, typically discharging to the nearest water body, collection levels are estimated to be no greater than 50% nationally (less than 20% in many rural areas). As per a careful estimation, the wastewater generated in Pakistan is directly used for irrigating an area of about 32,500 ha (Ensink et al., 2004). The estimated total amount of direct wastewater used in agriculture is 0.876 x $10^9 m^3$/yr while that directly disposed of to water bodies, mainly irrigation canals, is around 0.146 x $10^9 m^3$/yr (WB-CWRAS Paper 3, 2005).

Commonly grown crops include vegetables, fodder, cotton and to some extent rice. Vegetables receive wastewater irrigation almost twice a week, fodder once a week and cotton after 3 weeks. The crops grown in suburban areas while using wastewater include vegetables, and fodder as these fetch high prices in nearby urban markets.

The quantity of N, P and K applied from sewage irrigations of 0.40 m in Faisalabad ranged from 116 to 195, 7 to 21 and 108 to 249 kg ha-1, respectively. These quantities of N and K are quite sufficient for

any crop while that of P is low and would need to be supplemented. Since P applied through sewage is 100% soluble, its availability is generally much higher than P applied through fertilizers. In another study conducted at Haroonabad (Pakistan), up to 2030, 1110 and 1580 kg ha-1 of N, P and K, respectively, per cropping season were added to the soils when crops were irrigated with sewage (Ensink et al., 2002). Efficiencies of nutrients (excess of nutrient above the recommended rate) applied through sewage irrigation ranged from 140 to 920 for N, 20 to 790 for P and 125 to 930 % for K, depending upon the crop type and amount of sewage (Ensink et al., 2002). This estimated pollution indicates that sewage application to most of the crops may exceed N and P fertilizer needs over the growing season (Murtaza et al., 2010). When plant nutrient needs do not coincide with irrigation needs, the presence of nutrients in irrigation water may be problematic. For example, ill-timed and over-fertilization with N can cause excessive growth, encourage weed growth, increase chances of lodging and thus reduce crop yield (Asano and Pettygrove, 1987; Bouwer and Idelovitch, 1987). Moreover, presence of such nutrients in local water bodies can lead to eutrophication and thus deteriorating water quality and aquatic life. Yield and quality have been harmed by excess N in many crops, including tomatoes, potatoes, citrus, and grapes (Bouwer and Idelovitch, 1987).

The wastewater used for irrigation is valued by farmers, mainly because of its nutrient contents and reliability of supply. Reuse of wastewater has many positive impacts on socio-economic aspects of the users. The data of Anwar et al. (2010) show that there is a major increase in price of agriculture land due to availability of wastewater and the average land value was Pak. PKR 0.3 million per acre before the reuse of wastewater while after the availability of wastewater as alternative irrigation source it has increased up to PKR 0.4- 0.6 million per acre. Similarly, monthly income of 87% households has increased and 77% respondents replied that employment opportunities have been generated. These are positive impacts on agriculture land values, households, monthly income and employment due to reuse of wastewater.

Land treatment of partially treated wastewater has been used as a low-cost method of wastewater disposal for a very long time. In Haroonabad (Pakistan), land irrigated with wastewater has a higher value than the canal irrigated land, and the land rents of wastewater irrigated farms were on average three and a half times higher than those of canal water irrigated lands (Hassan et al., 2001). Considering economics, impacts of wastewater irrigation can be grouped under:

1) potential yield losses in the long run,
2) loss of soil productive capacity,
3) depreciation in market value of land, and
4) cost of additional nutrients and soil reclamation measures.

After initial study by Ensink et al. (2004), several researchers of the country have focused on this area which was neglected in recent past. Further working on this aspect may only encourage growers about less use of chemical fertilizers unless they are equally educated about ill effects of wastewater irrigation on soil chemical and physical properties in addition to contamination of human food chain and related health risks.

17.5 Policies and institutional set-up for wastewater management:

17.5.1 Policy aspects and national strategy

There seems to be no national policy, in effect, on sustainable use of wastewater in this country. Moreover, economic incentives have not been introduced for industries to acquire environment friendly technology. Problems of wastewater disposal tend to stem from distortions due to economy-wide policies, failure of targeted environmental policies, and institutional failures. Uneconomic water pricing exacerbates the problem in urban areas, where a flat rate is charged or water is provided free of charge,

a policy that both encourages the wasteful use of water and eliminates incentives for suppliers of water services to upgrade their water supply, treatment, and disposal facilities. Laws and regulations have been formulated about treatment and disposal of wastewater in this country but their implementation due to lack of resources and skilled manpower is the real issue. The result is that, while an appropriate and necessary administrative capacity exists on paper, its effectiveness is seriously curtailed in practice due to these shortcomings. For example, the NEQS for industry and municipal discharges were originally formulated in 1993, but even voluntary compliance and reporting have yet to be instituted because of a lack of practical monitoring ability in the EPAs; the Environmental Impact Assessment (EIA) system is mandatory but seldom followed in the public sector; and environmental laboratories have been established in all provinces but function with skeletal staff and budgets inadequate even for their routine equipment and chemical needs. Similarly, environmental tribunals have been created but their capacity to deal with reported cases is extremely restricted, as minimal personnel have been deputed in only two provinces to collectively oversee the entire country (WB-CWRAS Paper 3, 2005).

The biggest challenge faced by policy makers at present, is how best to minimize the negative effects of wastewater use, while at the same time obtaining the maximum benefits from this resource. While most of the impacts of wastewater use, both negative as well as positive, are generally known, a comprehensive valuation of the benefits and costs of these impacts has not as yet been attempted. Conventional cost benefit analysis is not adequate to evaluate wastewater impacts due to the environmental and public good nature of the impacts (Hussain et al., 2001).

Prime importance should be given to the treatment of industrial effluent before it is allowed to pour in Drain. The environmental laws and their implementation need to be dealt more seriously and responsibly. The practice of usage of untreated wastewater for irrigation of fields should be immediately stopped as it is harmful for the consumers of those vegetables and crops. Pumping of groundwater near wastewater drains for drinking purposes must be avoided. In some cases, sewage is auctioned by the municipalities to the highest bidder, often a group of rich farmers, who then rent out their fields to poor landless farmers. Under these conditions, the use of sewage is considered a win- a - win situation by both the authorities those are responsible for sewage disposal and the farmers who get its reliable supply with high nutrient content (Ensink et al., 2004). In relation to wastewater irrigation, economic analyses should also have to conduct with precise perspectives keeping in mind for example municipality optimizing treatment costs, or farmers or a regional entity maximizing income, or evaluating environmental impacts.

17.5.2 Organizational set-up and Responsibilities

Following organizations are involved in carrying out checks and studies on wastewater availability, use and its disposal. The data provided by these organizations is highly acknowledged.

National organization(s)

1. Pakistan Council of Research in Water Resources (PCRWR)
2. Pakistan Council of Scientific & Industrial Research (PCSIR)
3. Pakistan Environmental Protection Agency

Regional (local) organization(s)

1. Institute of Soil and Environmental Sciences, University of Agriculture Faisalabad, Pakistan
2. Centre of Excellence in Analytical Chemistry, University of Sindh, Jamshoro, Pakistan
3. Centre of Excellence in Water Resources Engineering, University of Engineering and Technology Lahore
4. Institute of Environmental Studies, University of Karachi
5. Department of Soil and Environmental Science, University of Peshawar, Peshawar

6. Institute of Soil Chemistry, Ayyub Agriculture Research Institute Faisalabad
7. Department of Soil Science, University of Arid Agriculture Rawalpindi
8. Urban Resource Centre Karachi
9. Water And Sanitation Agency (WASA)

Other organization(s)

1. International water Management Institute (IWMI)
2. IUCN Pakistan
3. Water Aid Pakistan
4. WWF Pakistan

Point Needing Attention

16 organizations are already working to put the Genie of Wastewater into the bottle. Education and awareness of the managers and users and the common man who will ultimately be the ***loser*** - *has to be given the top most priority*.

17.6 Research/practice on different aspects of wastewater:

Up-till now, there is no center for research on wastewater that deals exclusively with this issue. Instead, various departments of educational and research bodies randomly do some research work on this aspect. Most of the studies are published in local journals due to poor quality of the project work. There is dire need to fortify such scattered efforts so that a collective future action plan could be devised well in time. For example, up- till now, there is no short term or long term study available that explains ill effects of wastewater, if any, on soil physical properties, in this country. In Pakistan where safe effluent disposal facilities and its treatment are non-existent or limited, raw sewage is used to irrigate fodders, ornamental and food crops including vegetables (Murtaza et al., 2010). Based on the studies in the past – the parameters enticing farmers on using wastewater for irrigation and the negative impacts and health hazards which haunt the nation are briefly discussed as below:

17.6.1 Wastewater – Monitory Gains for Farmers

Ensink et al. (2004) estimated that:

- Average gross margin for a sewage user farmer in Pakistan was US$173/ ha, which was substantially higher than
- Farmer using canal water, about US$43/ ha, mainly because of higher cropping intensities and the ability to cultivate crops with higher market values.

In a study from Faisalabad District, Punjab, Pakistan (Baig et al., 2011), net benefit from crop production per Pakistan rupee invested for:

- Wastewater irrigation returned PKR 5.56 on an average - as compared to;
- PKR 2.20 for fresh water irrigation.

Reuse of wastewater has many positive impacts on socio-economic aspects of the users. The data of Anwar et al. (2010) show that there is a major increase in price of agriculture land due to availability of wastewater and

- The average land value was PKR 0.3 million per acre before the reuse of wastewater
- While after the availability of wastewater as alternative irrigation source it has increased up to PKR 0.4- 0.6 million per acre.

Similarly, monthly income of 87% households has increased and 77% respondents replied that employment opportunities have been generated. These are positive impacts on agriculture land values, households, monthly income and employment due to reuse of wastewater – however, the health hazards cannot be ignored.

17.6.2 Negative Impacts – Health Hazards

- in wastewater area were 11.44 days per person per annum; as compared to
- 8.04 days in fresh water area.

Ashfaq et al. (2010) in a study reported that

- In case of wastewater use areas, per person health expenditures were PKR 4178; as compared to
- Fresh water used areas where it was PKR 3537, due to higher number of days of illness in case of wastewater use areas around Faisalabad.

In developing countries including Pakistan, little work is being conducted on this very important research area. Limited information is available on the physical treatment of effluents and soils, bioremediation of effluents and soils, advanced chemical oxidation treatments, thermal remediation strategies, waste landfills and amendments to decrease bioavailability. The restriction in research seems to be related solely to the high cost of implementation on such research. Under these circumstances, at least crop restriction can be used to protect the health of consumers when water of sufficient quality is not available for unrestricted irrigation. For example, water of poorer quality can be used to irrigate non-vegetable crops as cotton, lawns, ornamental or crops that are cooked well before consumption. There is also lack of information regarding both the short and long term effect of wastewater on soil physical properties which needs to be addressed. Moreover, if polluted water treatment at the source is not economically feasible at this time then there should be screening of crop genotypes which are hyper-accumulators of heavy metals in their eatable portions, especially vegetables. Laws should be framed, to encourage farmers to grow only those genotypes which accumulate relatively very low amounts of metals in their eatable portions, especially around major cities of Pakistan. While genotypic/cultivar differences in plant uptake of metals are well documented but absolutely no work has been conducted in this regard in Pakistan. There is hardly any well organized study conducted in this country which focused on risk assessment in a systematic way. Moreover, there are no studies which concern heavy

metals bioavailability employing animal trials. Some of the systematic work has been done by IWMI and Pakistan Environmental Protection Agency with financial aid from foreign donors.

17.7 Status and need for the knowledge and skills on the safe use of wastewater:

While a comprehensive national policy and institutional framework for environmental management is in place, there are significant weaknesses in the current administrative and implementation capacity, typical of a developing country setting like Pakistan. Principal among these are a ubiquitous shortage of trained manpower and insufficient budgetary allocations, a lack of clear definition of roles, work plans and targets, specific capacity gaps on the safe use of wastewater in irrigation by individuals or institutions dealing with wastewater management, and ineffective coordination and communication between federal, provincial and local administrative entities. Most urgently needed is the availability of skilled human resources for implementing national or international guidelines for the safe use of wastewater in agriculture or other purposes. There are no regulations in existence that guide what to be grown with wastewater. Farmers should be made aware of and encouraged to grow resistant and non food plants (i.e. fiber crops, lawns, parks and ornamental plants) with wastewater irrigation. A clear and practical strategy needs to be defined to implement existing policies. There is dire need to minimize weaknesses in coordination among different sections of the society including the general public, organizations, industrialists and farmers. Moreover, there is also need to prioritize the knowledge and skills and develop capacities within various institutions to deal with different aspects of safe use of wastewater in agriculture.

17.8 Conclusions

Pakistan's water-resources have been diminishing at an alarming rate, as can be concluded from the above-stated facts. It is now a water deficit country. The water availability has decreased from 1,299 m^3 per capita in 1996-97 to 1,100 m^3 per capita in 2006 and that of projected less than 700 m^3 per capita by 2025. Therefore, search for other non-conventional water resources for irrigation i.e. wastewater has become important.

In Pakistan, it is estimated that around 2,000 million gallons daily and 962,335 million gallons annually wastewater is being produced and discharged to surface water bodies. This domestic and industrial wastewater is either discharged directly to a sewer system, a natural drain or water body, a nearby field or an internal septic tank. This wastewater is normally not treated and none of the cities have any biological treatment process except Islamabad and Karachi, and even these cities treat only a small proportion (<8%) of their wastewater before disposal.

The wastewater used for irrigation is valued by farmers, mainly because of its nutrient contents and reliability of supply and exert positive impacts on agriculture land values, households, monthly income and employment due to reuse of wastewater despite of the ill effects of wastewater irrigation on soil physical and chemical properties in addition to contamination of human food chain and related health risks.

Limited information is available in this regard and needs capacity development. There seems no national policy in effect on sustainable use of wastewater in this country. While a comprehensive national policy and institutional framework for environmental management is in place, there are significant weaknesses in the current administrative and implementation capacity. A clear and practical strategy needs to be defined to implement these policies. Moreover, economic incentives have not been introduced for industries to acquire environment-friendly technology.

Problems of wastewater disposal tend to stem from distortions due to economy-wide policies, failure of targeted environmental policies, and institutional failures. Thus laws and regulations have been formulated about treatment and disposal of wastewater but their implementation due to lack of resources and skilled manpower is the real issue. There is hardly any well organized study conducted which focused on risk assessment in a systematic way.

Some of the systematic work has been done by IWMI and Pak-EPA with financial aid from foreign donors. Therefore a well coordinated program is necessary to create awareness among different sections of the society including the general public, organizations, industrialists and farmers and to remediate polluted wastewater by using modern techniques.

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18. CONCLUSIONS: ENTREPRENEURS TO THE RESCUE?

Suleman Najib Khan

18.1 Water Resources / IBIS our prolific asset ~ Understand it!

The three 2004 letters of late Lt. Gen (Rtd) Dr. G. S Butt to the President & one to WAPDA be taken as articles of faith. They are part of the WRDC archives. This great geo-physicist and engineer was highly skeptical of an early completion of Bhasha-Diamer. He was born and raised in Sind where his father was an irrigation engineer at Sukkur Barrage. Punjab, KP and Balochistan's irrigation water needs could even be apportioned by Sind based on the 1991 Accord. Punjab is open-hearted on this.

The statistics about reduced water flow into Pakistan rim stations from IHK are disturbing. Global warming will increase glacier melt and there will be greater surface flows for the next few decades. As one of the main architects of the incredible KKH and as a former Chairman of WAPDA Dr. Butt understood the ground realities. This he forcefully conveyed to the incumbent Chairman WAPDA its managers and consultants on 30 June 04 during a meeting which was a result of his first letter of 2004 to the President. He was convinced that Diamer-Basha (DBD) cannot be larger than KBD due to its location. Its height as per Monenco feasibility should be within safety limits. He felt that both dams should be started as soon as possible. Dr. Hon. Shamsul Mulk was very critical about the height increase and states thatit was crude & hazardous attempt to eliminate downstream KBD.

A message of the legendary late S. S. Kirmani from the USA was received on the eve of the Conference on Water Reservoirs in the National Economy convened at Islamabad in Feb 1998. Syed S. Kirmani Sahib who was living in USA. I quote extracts of this fax dated 04 Feb 1998:

Quote

"Few countries are blessed with such rich land and water resources as Pakistan. It has also been blessed with an ideal climate for year-round cropping. Many experts point out that Pakistans potential for agricultural production is greater than that of California in the United States. The International Food Policy Research Institutes (IFPRIs) studies identified Pakistan and Thailand as the only two countries in Asia that have the potential for exporting food on a sustainable basis in the 21 century. Despite large hydropower resources Pakistan is depending increasingly on costly oil and coal imports for meeting its power needs. It is time to examine the main causes for Pakistans predicament. It is time to examine why Pakistan has not been able to develop its land and water resources so effectively; why the irrigation engineers base their water demand on historic withdrawal instead of matching water supply with crop requirement; and why important issues such as the amount of surplus river flows available for storage disposal of the Basins saline effluent to sea and measures for protecting the ecology of the Indus delta remain unresolved for many decades. It is also time to ask why Pakistan has not been able to exploit the great opportunities for water resources development opened up by the 1991 Water Apportionment Accord. The Federal ministries should have played a proactive role to build consensus but they remained passive and were unwilling to face the challenges of the issues. Thus everybody blamed everyone else for the lack of progress and the issues became more controversial with time. Pakistan's aspirations for realizing the full potential of its rich land and water resources will remain a dream if the prevailing controversies on water issues continue. There is a need for exploring a new strategy that does not suffer from constraints of past approaches and which provides better prospects of success."

Unquote

18.2 Wastewater Treatment and recycling

A Water Report from Australia has been the source of some valuable scientific advice on managing wastewater and providing a strategy for its recycling & reuse. CISRO Australia reports that water is becoming an increasingly valuable commodity and this provides incentive for greater investment in new technologies to manage wastewater treatment. Opportunities to reuse &recycle water continuously is the challenge not only to secure the environment but is an efficient business model. Remedy of polluted sediments may use chemical procedures (e.g. oxydation or reduction) depending on each community's outdoor water use.Upto 75% of water supplied becomes sewage effluent, which could be recycled to offset input of additional water. Water management includes segregation of greywater and partly recycled water for garden watering and partly for use in toilet flushing. Measures being pursued by Australian utilities include generating renewable energy by installing mini hydro systems in pipelines, recovering biogass during wastewater treatment etc. From a wastewater management perspective, the removal of nutrients such as phosphorus and nitrogen contained in human waste is the primary focus for current sewage treatment. Australia limits the discharge of other contaminants to sewer systems to avoid waterway pollution. The result is upgraded sewage treatment plants which use advanced biological treatment processes to improve effluent discharge quality. The concept of phosphorus based fertilizers will also be possible from treated wastewater. Similarly there could be benefits of recovering nitrogen from wastewater as an alternate source of nitrogen fertilizer. Human waste contributes about 80% of the nitrogen and phosphorus in domestic sewage. It is estimated that the Pakistani population excretes nearly one million ton of nitrogen per annum and about 0.5 million tons of phosphorus. As stated earlier the separation of greywater and blackwater (toilet wastewater) becomes economical. Blackwater separation requires additional collection pipelines. This cost could be offset by new income from the fertilizers and energy produce, sale of recycled greywater etc.

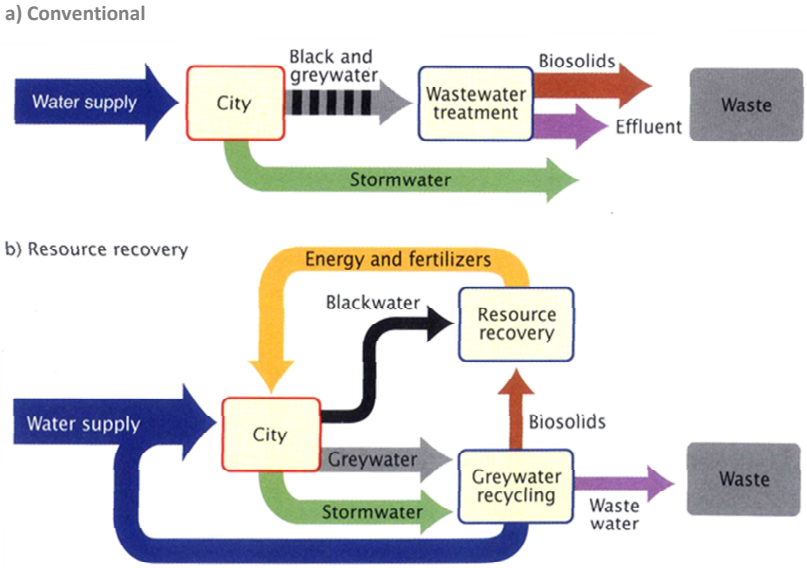


Figure shows a conventional urban water system compared with one designed to recover resources from blackwater and recycled greywater. Courtesy CSIRO, Australia (2011).

Reuse systems contain advance water treatment such as dual membrane systems that combine micro or ultra-filtration with RO. In many cases, advanced oxidation using UV disinfection is used as an additional treatment barrier to ensure almost complete removal of all traces of biological & chemical contaminants.New technologies are now practiced whereby the final wastewater sludge disposal ensures 100% conversion to valuable oil (cellulose) and leaves no waste behind as the ash residue is used in cement factories as a binder.

18.3 Solar PV Powered TW pumping. A logical step

Electric power generation from imported oil is too expensive & unreliable for sustained growth. It needs a mix of hydropower! Solar powered tube-well pumping of aquifers could become viable. Mined water lacks the rich minerals of flowing river waters but is extensively used when there is no alternate. Around 40 MAF water is pumped annually in both the Punjab and KP.

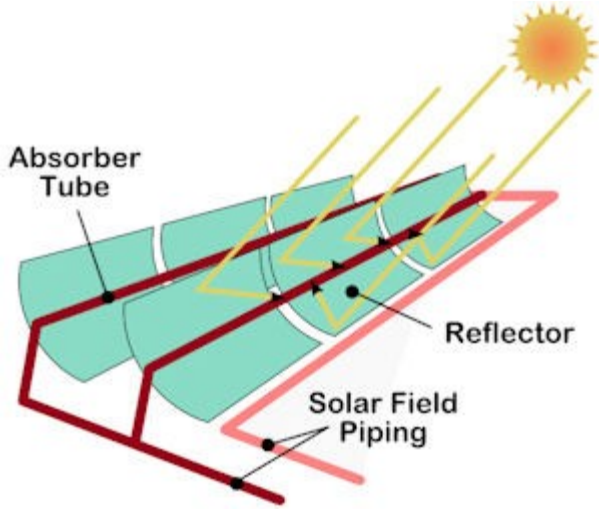
18.4 Financial Scenario ~ Use your assets. Raise debt for development

The deficit in fiscal and budgetary terms is growing at an alarming speed. It has further aggravated the crisis as we cannot produce more (and ofcourse export more). Short term borrowing by the public and private sector institutions is not going to be helpful in the long run. OECD-Helsinki 1992 is a watershed in the financial bazaar. The 25 rich nations decided that the cake will be shared by many more nations of the former second world and that concessional financing on bilateral basis was to be discouraged. The energy policy based on uncapped imported energy has the potential to be the most damaging blow to our economy.

New reservoirs & HPP as part of the Great Indus Cascade (2015-2040) would add29,650 MW providing 104,400 GWh of hydro-electric energy per annum. Refer Chapter 14. Private hydel sponsors must receive comprehensive hydrological and geological site risk cover from the GoP for private sector HPP projects in KP, Punjab & AJK. They must be motivated to participate.

18.5 Tech Frontiers~ new sources of Renewable Energy &desalinization of seawater

Desalination will be soon becoming a major source of water for Karachi and for the entire Mekran coastline including the future metropolis being created at Gwadar port. Concentrated Solar Power (CSP) using parabolic troughs focusing on a concentric pipeline containing mineral oil. The system is capable of raising temperature of mineral oil to 400°C for steam etc.



The time for renewables has arrived. The future belongs to hydropower but also to solar power windpower and hydrogen fuel-cells. The World Energy Report predicted in Nov 2005 that USD 17 Trillions would be required worldwide by 2030 to meet the energy challenge. As energy demand will rise by 50% the emissions could unfortunately increase by a similar percentage.

18.6 Sasti Bijli (Cheap Electrical Energy)

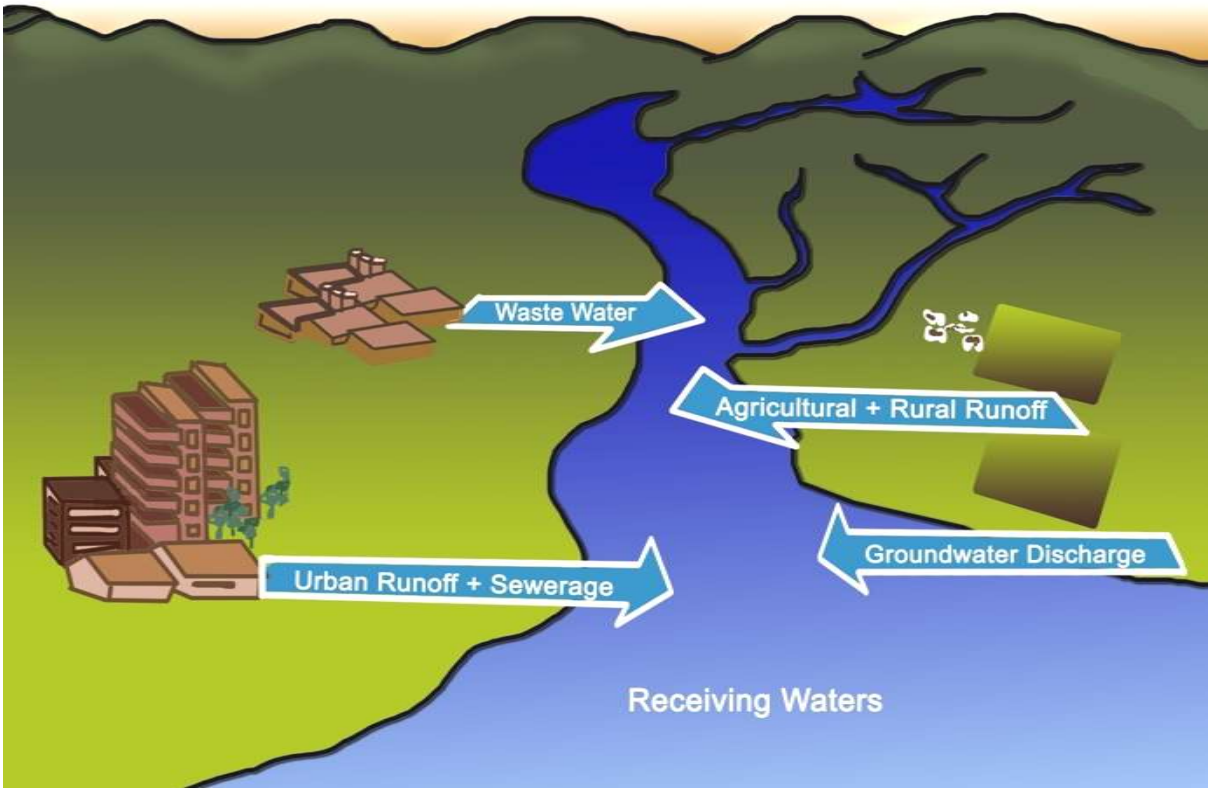
Severe attrition of water reservoirs and have given the economy an unsustainable liability. The SASTI BIJLI slogan has to be implemented to revive major industrialization and assist agriculture. The private sector be given the ultimate support to strengthen the local engineering industry. Technological milestones need to be identified. The key to revival and rejuvenation of public and private sector institutions including strategic industry rests with their capability to indulge in good asset management. This must include access into world capital markets. The truth is that WAPDA which is the True Economic Headquarter of Pakistan is mortally weak and cannot use its balance sheet any longer to construct major power projects.

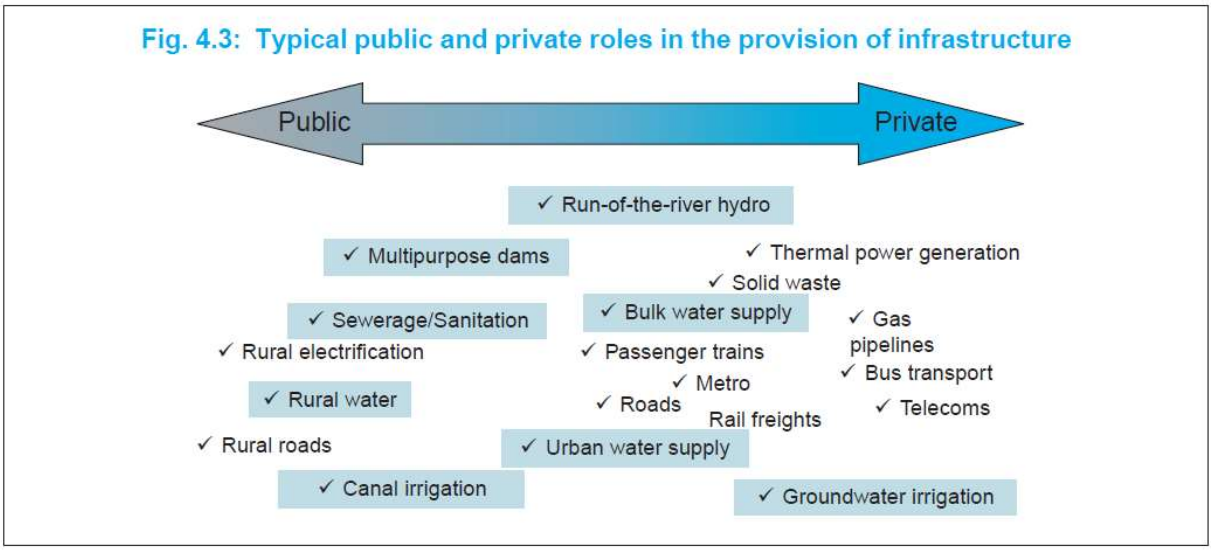
The additional flooding due to global warming has to be catered for. The leadership has to find a political solution to the agitation by elements in KP and Sind provinces. It is not just a battle for the hearts and minds of ill-informed brethren. It is the battle for Pakistan's survival. As important as any other struggle being waged today. The Indus Waters Treaty of 1960 is sacrosanct and India must continue to respect it. Pakistan desperately requires new storages and the world knows it. Without this the poverty cycle cannot be broken and uncontrollable anarchy lies ahead in this nation of 190 million souls. The role of sweet water is central to Pakistan's financial sustainability and survival. It is blessed with five of the seven largest glaciers on the planet. This is the biblical truth that may not be violated.

The Quranic verses Sura XIV IBRAHIM (Verse-32) Sura XXVII NAMAL (Verse 60 and 61) and Sura FURQAN (Verse 48 to 50) are some of the divine messages on water that may not be ignored if we wish to remain a living nation. The Indian factor has to be understood. Several difficult decisions will have to be taken and the self-seeking policies must be permanently rejected. Industrialization through a real technology transfer has to be managed. Local energy sources will have to be the primemovers of the programme. The vultures are circling.

Appendix:

Potential sources of pollutants to waterbodies (A case of recover, recycle and reuse)



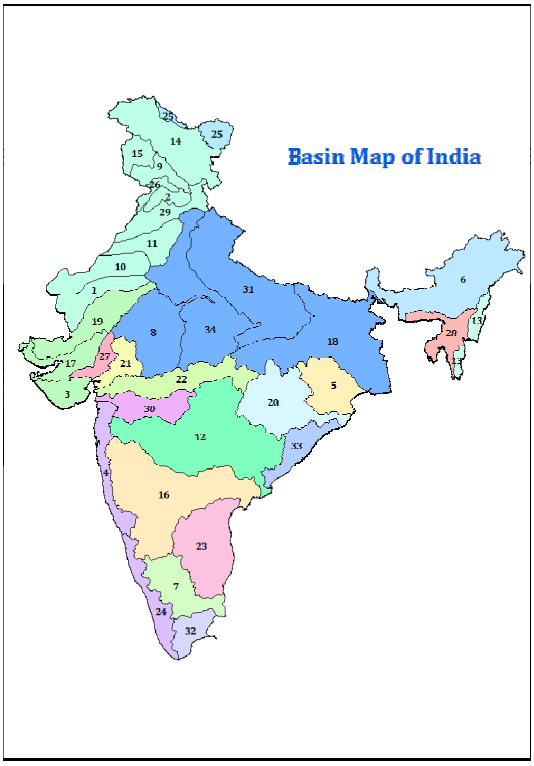


Courtesy: "PAKISTAN'S Water Economy Running Dry" (John Briscoe • Usman Qamar)

Appendix: River Basins of India.Classification under CGWB Basin.

In this Atlas, the entire river system of the country have been divided into 34 basins as per central ground water board.

Sr. #	Basin Code	Basin Name	Area(sq.km)
1	1	Barmer	58163
2	2	Beas	19562
3	3	Bhadar	36502
4	4	Bhatsol	54878
5	5	Brahmani	79815
6	6	Brahmputra	186873
7	7	Cauvery	85457
8	8	Chambal	130665
9	9	Chenab	29937
10	10	Churu	66316
11	11	Ghaghar	51438
12	12	Godavari	301888
13	13	Imphal	24476
14	14	Indus	137655
15	15	Jhelum	29231
16	16	Krishna	265505
17	17	Kutch	52880
18	18	Lower Ganga	249661
19	19	Luni	87393
20	20	Mahanadi	133665
21	21	Mahi	3870
22	22	Narmada	93398
23	23	Pennar	139463
24	24	Periyar	54580
25	25	Qura-qush	29683
26	26	Ravi	13230
27	27	Sabarmati	24995
28	28	Surma	50278
29	29	Sutlej	54458
30	30	Tapi	63347
31	31	Upper Ganga	231127
32	32	Vaippar	38565
33	33	Vamsadhara	50792
34	34	Yamuna	203641



Introduction of River Basin in India:
River basin is considered as the basic hydrological unit for planning and development of water resources. There are 12 major river basins with catchment area of 20000 km^2 and above. The total catchment area of these rivers is 25.3 lakh km^2. The major river basin is the Ganga-Brahmaputra-Meghna , which is the largest with catchment area of about 11.0 lakh km^2 (more than 43% of the catchment area of all the major rivers in the country). The other major river basins with catchment area more than 1.0 lakh km^2 are Indus, Mahanadi, Godavari and Krishna. There are 46 medium river basins with catchment area between 2000 and 20000 km^2. The total catchment area of medium river basins is about 2.5 lakh km^2. All major river basins and many medium river basins are inter-state in nature which cover about 81% of the geographical area of the country.**There are five classifications.**

A) Minutes of three formal meetings of 2012

B) Minutes of three formal meetings of 2015

C) CIBSA our response to the ICID challenge; Global warming

D) John Briscoe's essay "Peace, not water, on the Indus" and his original essay "War or peace on the Indus?"

E) Two PCA Decisions of 2013 on India's Kishenganga HEP

F) Abstract of The Great Indus Cascade (2015 – 2040). A proposal overdue!

A-1 MINUTES / DELIBERATIONS OF 1ST MEETING

Pakistan Economic Forum-II
Water Panel
Meeting 13 Nov 2012

Sub: Draft concerning deliberations of the first meeting held on 13 Nov 12 at Lahore

The meeting was attended by:

1. Mr. Sikandar Mustafa Khan
2. Mr. Khalid Mohtadullah
3. Mr. Bashir A. Chandio
4. Mr. Shamshad Gohar
5. Mr. Suleman Najib Khan

Specific comments by the committee members:

Khalid Mohtadullah:

- The ground water resource is roughly seven Tarbela reservoirs.
- Inter seasonal storages are critical for better utilization of our water & ground resource. Let us remember that 70% of surface waters are available during three months of the year. The absolute quantum is not as important as its timely availability.
- Ground water (GW) quality is rapidly deteriorating.
- Climate change will eventually bring serious repercussions as Indus is 70% glacier fed.
- 60% of the glaciers feeding Jhelum are already gone.
- We need to use every drop of water. Therefore water management has become critical.
- The awareness of the coming water crisis is not appreciated. Industry presently uses only 5% of the water available. Soon there will be no additional water for industrial use.
- PRC has improved water management. Agriculture in China now consumes 60% instead of the 80% water quantum used earlier.
- Pakistan's hydro assets (irrigation as well as WAPDA assets) are unleveraged. An asset of around USD 700bn to USD 1tr is available for corporatization etc.

Shamshad Gohar:

- Arsenic in ground water is a major issue. Bacteria can be fought but arsenic is a serious matter. In Lahore out of 220 tube wells, 142 had bacterial contamination. A large number was showing arsenic poisoning. The FODP report is soon ready and can be studied.
- We can still convince people for better management of water resource.

Dr. Bashir A. Chandio:

- 16 MAF live storage in 1974 has been reduced to less than 11 MAF.
- Ground water passages / drainages are blocked in Sindh due to mismanagement. This was witnessed during recent floods. The damage was therefore much greater.
- Still in favor of water reservoirs especially on Indus River. However Indus water belongs only for the people of Sindh.

- New land for agriculture will be necessary when new reservoir capacity is available. Water management & land use / agricultural practices must be improved.
- Silting of large dams is a great issue especially at Tarbela.
- Is arsenic in ground water caused excessive use of pesticides?
- Hepatitis is also rampant due to ground water contamination.
- Riverine storages with aquatic life can be adequate. Pakistan has not taken good care of its water bodies and natural storages thereby disturbing the hydrologic balance.

Khalid Mohtadullah:

- The traditional average canal diversion of 104/105 MAF for irrigated agriculture already reduced to 95 MAF. From where will be new water available if new reservoirs are not built? In tandem water and land productivity must be increased.
- Replacement value of irrigation assets as estimated in 1987 by the legendary Mr. S.S. Kirmani were USD 300bn. Ghazi Barotha & even Mangla & Tarbela dams can be used as collateral through corporatization. Some shares can be sold to the private sector.

Dr. Bashir A. Chandio:

- On farm management did not work. We could use the intangibles for this corporatization.

Shamshad Gohar:

- We have to involve the 5 to 6mn farmers to improve the water & land management. We must convince them to grow the correct crops and use minimum water for the purpose.

Khalid Mohtadullah:

- The Chinese have involved the farmer in saving & conserving water with three strategic mantras: 1. Water saving, 2. Water saving, 3. Water saving. In any case they have reduced agriculture use of water from 80% to 60%.
- There are pockets in Punjab, Sindh, KP & even Baluchistan where there are very good yields. Comparable with India, Argentina, Australia, Mexico etc.
- Indians clearly draw our ground water resource from several points.
- Water returned to the system has to be good / clean. This applies to both agriculture use and industrial drainage.

Shamshad Gohar:

- There is contamination in Sialkot & Gujranwala although the ground water is sweet up to 1700ft.

Dr. Bashir A. Chandio:

- Industrial waste water is useable. Industrial effluents should be treated. GW is also to be treated in case of incorrect / untimely use of pesticides. Punjab should use more GW.

Khalid Mohtadullah:

- I disagree with Dr. Chandio. The GW resource is already over-mined / overused. Punjab uses +50% GW for agriculture.
- In China Yangzte water through good water management is also provided to the Yellow River Basin.

- In years of high flow we should recharge the aquifers through inducement. In case there is sea water in aquifer the fresh water with a lower specific gravity will float on sea water. Therefore you can use skimming wells.
- In Baluchistan tube wells are drawing water from upto 1800ft to grow wheat. This is wasteful.
- GW recharge in Punjab and Sindh (for its good quality GW areas) is definitely required.
- Agriculture is still responsible for 25% GDP contribution but value added agro industry has an even bigger role in the economy.
- Trade with India has to be carefully managed so that it benefits both sides. For this purpose also think tanks must play their role.

Dr. Bashir A. Chandio:

- Flood passage ways and natural drainages were blocked since pirs / faqirs had taken control of land and innocent people were drowned. Indus estuary has to be sustained.

Khalid Mohtadullah:

- KP will have no Indus Waters share without KBD. Today 0.8mn acres in South KP is requiring water for basic agriculture needs. "Think tanks" have to be created to augment the existing know-how and knowledge in this critical subject. Our neighbor has available a great reserve of knowledge and information to draw upon. We must learn quickly.

Suleman N. Khan:

- If correctly interpreted the IWT 1960 does not require any race between the two countries. Once Pakistan has shown its intentions for irrigation or hydroelectric use on a Western river the Indian are forbidden to divert any upstream waters or transfer any waters of the tributaries or the main stems of these three rivers. The spirit & letter of the IWT 1960 absolutely grants exclusive rights to Pakistan. India has to be made to respect Pakistan's rights on the Western rivers. It is time for the Indians to open the entire valley for inspection by neutral experts. Certainly both nations were born from the same womb and as such owe great ties to one another. Based on this Pakistan can offer India vast partnerships in economy & culture.

A-2 MINUTES / DELIBERATIONS OF 2nd MEETING

Pakistan Economic Forum-II
Water Panel
Meeting 27 November,2012

Sub: Draft concerning deliberations of the second meeting held on 27 Nov 2012 at Lahore.

The meeting was attended by:

1 Mr. Sikandar Mustafa Khan
2 Begum Dr. Zaigham Habib
3 Mr. Bashir A. Chandio
4 Mr. Shamshad Gohar
5 Mr. Suleman Najib Khan

A clarification of the note circulated with respect to the first meeting of 13 Nov 12.

The statement of Mr. Shamshad Gohar may be understood as "Ground Water in Sialkot & Gujranwala is fresh at 1,700ft. However at lower depths especially upto 200ft it can be classified as bad (bacterial contamination, fluorides, nitrates, arsenic & heavy metals)".

Summary of the discussion on 27 Nov 12:

Dr. Zaigham Habib: Said there is no national water policy. She was very critical of the lack of R&D and "Think Tanks" on water issues. Hardly any written material is produced at both national and provincial levels. **In fact Pakistan needs an Institute on Water Management.** It could also provide backup for WAPDAs Water Management & Flood Control departments, clearly a dysfunctional organization since some years. The nation has no mechanism to account for water use etc. Water productivity cannot be accurately calculated. This is a serious dilemma. Commented that Shamshad Gohar Sahib has written good reports but a more detailed analysis on GW is required. Further commented that on water use / efficiency we are perhaps at an optimum in the Punjab. In Sindh they lack good GW but use excessive surface waters.

Lining of canals in the Punjab is unnecessary. The aquifers are recharged and the seepage water is not lost as long as the GW is of good quality. We definitely pump more than what we put back into the ground. How many times do we recycle? Dr. Sahiba also made a very pertinent and thought provoking remark; the Jordan River Treaty as well as the Indus Waters Treaty are the two worst treaties in history. Both treaties ignore the vital issue of drinking water. She also believes that if the Nile River Treaty could be revised seven times there is a possibility to revise the IWT 1960 but for this a sincere &extensive dialogue becomes necessary. She recommends Pakistan must continue a comprehensive dialogue with India on water issues.

She estimates that agriculture utilizes about 90% of the water resource and not 95% as earlier observed. The sugar industry directly consumes a crop that is heavily water dependent. She emphasized that we now pump more than what we put into the ground. Sindh land/agri development has been better than Punjab in the last ten years. However Sindh irrigated areas uses 2,000mm/yr whereas Punjab irrigated areas receive 500mm/yr. Farming patterns in Sindh are very irregular; varying from village to village and from farm to farm. Water Management is a highly complicated & risky subject in Sindh due to the use of cyclical flood waters & salaba. This is not useful and optimum for the national economy. In 2011 both FAO & Suparco reported that there was extensive damage due to canal breaches e g. On the Nara Canal.

Dr. Bashir A. Chandio: Water usage in Sindh is 3 cusecs for one hour per acre per week.

Dr. Zaigham Habib: Two adjacent farms in Sindh in the same village maybe having completely different agricultural productivity. There is a lot of pumping also of GW in Sindh.

Dr. Bashir A. Chandio: WAPDA says that 1000ppm is OK for agriculture.

Mr. Shamshad Gohar: Ab –e- Zamzam is analyzed with 4000ppm.

Dr. Bashir A. Chandio: Saline water is not good for crops but OK for humans & animals.

Dr. Zaigham Habib: Additional availability of water for agriculture has to be discouraged. The Indian Chenab Valley project is instructive. We must delink additional water availability from irrigation and make it available for other use; otherwise we are heading for a disaster.

Mr. Shamshad Gohar: Balochistan has surface water issues. They need more small dams.

Dr. Zaigham Habib:KP uses 5MAF surface waters and Baluchistan about 1.5MAF. (Dr. Sahiba was not sure how much flood waters from western nallahs is received by both provinces. However it is substantial and could be +10MAF some years).

Dr. Bashir A. Chandio: Make more run-of-river projects.

Dr. Zaigham Habib: Central Punjab Agriculture is at optimum/maximum levels. However South Punjab could definitely increase production if water availability is increased. She further recommended that water charges / levy may be increased. The GW exploitation of 40/45MAF in Punjab &KP is optimum and we may not depend on further enhancement of this resource.

Dr. Bashir A. Chandio: GW figures need to be confirmed.

Mr. Shamshad Gohar: There are 6000 skimming wells in Sargodha. This is a solution also for South Punjab. Sugarcane water requirement is greatest.

Dr. Bashir A. Chandio: Grow wheat also with sugarcane so it does not crop in January. Telemetry should work perfectly. Hydrographic calibration of weirs, canals needs better measurements (and calibration).

Dr. Zaigham Habib: Create an Indus Basin Authority. Do it on a public / private partnership. Her comments were similar to Mr. Mohtadullah's statement that Pakistan's hydro assets are unleveraged and therefore it is time for a rethink in strategy. She summarized:

"It is not a Demand Management Issue. Supply Management is in play. The provinces have failed to equitably manage the irrigation assets. There is no accountability in the Punjab Irrigation & its distribution functions. Atleast three (3) master plans since 1969 failed to deliver results".

Mr. Sikandar Mustafa Khan: Let us give a short term plan and a longer term plan.

Dr. Zaigham Habib: There are governance issues. There are research issues. There is sadly no continuous effort because of zero institutional support. However it is clear that the priority is Food Security and Hydel Power.

Mr. Sikandar Mustafa Khan: Water is a priority because oil is not sustainable. Food Security as well as Energy Security is essential for maintaining the required quality of life.

Dr. Zaigham Habib: Understand the assets and then the challenges are to optimize the economic value of both Surface Waters & Ground Water resource. Include particular crops such as silla rice. Increase productivity. The Revenue Department only collects about 30%. However the small landholder must pay lower tax. Abiana rates may be reviewed on a fair & equitable basis. There are great challenges in the water sector. These must be

addressed under a National Water Policy and Provincial level framework. Every country has one. Let us modify the existing Draft Policy in the Planning Department and get the provinces to agree.
Low cost hydropower can ensure livelihood through industrialization & mechanization. These will impact on the quality of life. Mr. Ahmed Khan Bhatti's Report: ADB 2004/5 could be instructive. IRSA does not understand the necessity of governance. Someone calculated that Islamabad City is supplied 130 gallons/day/person. Even if it is half of this figure it is preposterous.

The UN has Trans boundary Rights which must be understood by the Pakistani experts. Also why Kashmir is at the brink of an ecological crisis. Catchment management is not being done.

Mr. Suleman Najib Khan: Yes at the Closed Door Conference in New Delhi we did get the Indians to agree in July 2010 on a joint study of the Kashmir Watershed amongst other points. Now let us find a solution to the contentions issue of the second reservoir on the Indus. Why in 38 years we have failed to build the critical second reservoir on the Indus?

Dr. Bashir A. Chandio: I believe that the KBD project can be made possible if Punjab will forego its water share.

Mr. Suleman Najib Khan: You mean Punjab should forego its 37% share as agreed under the WAA of March 1991? The share is applicable for any new reservoir. The WAA 1991 is a prosperity sharing document. However electric energy is now such a serious problem that Punjab may just agree. However it seems unfair to deny KP its 14% share of water from any new reservoir. Similarly the 12% share of Baluchistan. The KP has huge issues of surface waters especially in their Southern belt.

Dr. Bashir A. Chandio: The share of KP& Baluchistan should be possible for the people of Sindh to agree on.

Mr. Suleman Najib Khan: Let us put your idea across to all our members. KBD is now vital for Sindh due to its intrinsic flood control component and Sindh must not oppose it under the unfortunate perceptions that are existing.

NB: Footnote by Co- Chairman

AA) Firstly I am grateful for the learned write-ups received from both Begum Dr. Zaigham Habib and brother Mr. Shamshad Gohar.

A critical subject but clearly the Pak side is seriously handicapped by the complete lack of accurate surface flow data that India should but does not provide. To fulfill the requirements of IWT India does periodically transmit data that is clearly "fudged" & therefore unusable. The PCIW secretariat at Lahore especially under its fifth commissioner Mr. Jamaat Ali Shah (1991-2010) has been terribly incompetent and clearly complicit. There was tragically no institution keeping a watch.

BB) Secondly I discuss the GW document (and The Ghyben-Herzberg Model illustration) as received from Mr. Shamshad Gohar. His humorous touch is much appreciated. We now understand the chemistry of skimming wells. The model gives a fascinating relationship between ground water above sea-level and fresh water below sea-level. His main article is much appreciated as he addresses not just GW but infact touches all aspects of the water scenario in Pakistan in **Section 1**. In the same section he also discusses the main threats to the GW resource; it includes the environmental aspect. Again in **Section 2** he discusses at length the existing scenario related to Water Quality. It is a frightening picture. The examples of over pumping of GW in Lahore & Quetta both show a depleting trend. He is correct to infer that other cities of Pakistan are also undergoing aquifer stress. Limited monitoring should be unacceptable.

GW pumping at some sites is clearly – 50m below the groundwater table, as per Gohar Sahib. His study shows that inspite of around 50% electric tubewells in KP& 42% in Baluchistan the farmers in Sindh & Punjab are merely having 10 to 11% of this cheaper energy source and resort to a great use of diesel operated tubewells. Absolutely crippling for the national economy as well as the farm profitability. The **Section 3** (Challenges) covers the GW management issues comprehensively. One can only wonder if it is possible to wake-up the nation through a political elite that refuses to understand the gravity of the water issues faced by the nation.

A-3 MINUTES / DELIBERATIONS OF 3rd MEETING

Pakistan Economic Forum-II
Water Panel
Meeting 12 December,2012

Introduction:
The meeting was attended by the following honorable members of the PEF Water Panel:

1 Mr. Sikandar Mustafa Khan

2 Mr. Shams ul-Mulk

3 Begum Dr. Zaigham Habib

4 Mr. Bashir A. Chandio

5 Mr. Shamshad Gohar

6 Mr. Khalid Mohtadullah

7 Mr. Sardar Mohammad Tariq

8 Mr. Suleman Najib Khan

This was the third & final meeting of the Panel. The earlier meetings were held in Lahore on 13 Nov 12 and 27 Nov 12. To facilitate the participation of honorable Shams ul-Mulk and honorable Sardar Mohammad Tariq the venue was shifted to Islamabad. The meeting was convened on the kind invitation of Mr. Shams ul-Mulk at his office at Nazimuddin Road, Islamabad. The significance of 12.12.12 was not lost on some of the honorable members. Two eminent irrigation engineers were sadly not able to attend due to poor health. They were Mr. Illahi Buksh Soomro and Mr. Bashir A. Malik and were dearly missed.

It was heartening to have three eminent former Members of WAPDA present at the meeting. In fact all three are from KP province and had served with distinction respectively during the 1990s. Sardar M. Tariq was the last to retire from WAPDA service. Mr. Shams ul-Mulk also served as Chairman WAPDA. After retirement he further served as a Federal Minister and even as caretaker Chief Minister of his native KP province.

The Terms of Reference (ToR) as agreed by circulation on 05 Nov 12 are consolidated below:

1. To understand the endowment of the water resources of Pakistan. To evaluate the value of water for Pakistan's economy when utilized for irrigated agriculture, industrial and municipal purposes. Indeed "water is life" and this is a hypothetical analysis. Any study of value of water must include the value of the irrigation infrastructure. The asset base known as the IBIS (Indus Basin Irrigation System) together with the infrastructure owned by WAPDA i.e. the dams, the barrages and the ancillary irrigation assets as existing. The gross water quantity must include surface waters as well as ground water resource.
2. To understand the letter & spirit of the Indus Waters Treaty 1960. What are the causes for the serious attrition of the flows of the three Western Rivers, Indus, Jhelum& Chenab as observed during the last three decades? Will India agree to share flow data of these three rivers and their tributaries as they flow through occupied Kashmir. In July 2010 at a conference in New Delhi the Indians had recommended a joint study of the watershed.
3. Can Pakistan sustainably increase productivity of its land and water through improved water management? However it has to be understood that Pakistan has lost due to silt/sedimentation in the

last four decades substantial reservoir capacity and already in the 1990s a major Dam should have been built just to recover this lost capacity.

4. What influence is climate change having on the availability of surface & ground water resource in the short to medium range? What environmental issues will arise due to the climate change scenario? The ground water contamination due to over exploitation / depletion of this resource is now serious. In Punjab arsenic is at alarming levels.
5. Since Pakistan has not built any large dam after Tarbela (1974) the Hydel potential has been seriously underutilized. Of the +80,000MW hydroelectric potential only 6,500MW has been commissioned since 1947. Ghazi Barotha was the first major run-of-river project and uses Indus Waters. Its peak output of 1450MW for several months of the year is a major low cost energy source for the economy during the last ten years.

Specific comments by the Panel members

After the welcome remarks by Mr. Shams ul-Mulk the attention of the Panel was drawn to the highly significant statements & observations of the two honorable members; both Ground Water (GW) specialists who seem to disagree on the state of the GW resource. Mr. Shamshad Gohar from Punjab is convinced that the GW / aquifers have been over exploited and the damage maybe irreversible. Dr. Bashir A. Chandio from Sindh has expressed his views in line with the well-known Sindh position viz: that Punjab has abundant GW resource and can manage without additional "Surface Waters". Furthermore Dr. Chandio's initial position was that the waters of Indus Main are for the exclusive use of Sindh & Punjab should depend on Jhelum waters from the Mangla reservoir. However KBD as a power generation project without canals for KP (or additional irrigation water for Punjab) could be acceptable. He has later clarified with the statement "I always say that Replacement Reservoirs and Dams could be acceptable for existing irrigation system and network. Under such treatment KBD maybe acceptable to the decision makers". Unquote

Mr. Shamshad Gohar: At least 142 tubewells studied in Lahore (out of 209) had serious contamination. Another random survey of 90,000 samples in 2008/9 and yet another survey of 48,000 samples confirmed about 60% were contaminated. Bacterial, heavy metals & arsenic.

Mr. Shams ul-Mulk: Water as water (for life) must be protected. Quality of the resource is now a critical issue. Secure the resource in a useable state. From the hills in the north upto Kotri the Indus Waters should be drinkable. Flow at Nowshera is averaging 21 MAF annually. If you pollute Chitral River or Swat River what will happen to Kabul at Nowshera? Water must be recognized as a strategic resource also for the use of future generations.

Mr. Khalid Mohtadullah: GW is the key resource. Once polluted it becomes nearly impossible to clean. The second reservoir on the Indus has been delayed for much too long. KBD is for all the people of Pakistan. It must become the resource of all inhabitants of Pakistan. Are you interested in life? Water is life. It is not an ordinary item and it has no substitute or alternate.

Dr. Bashir A. Chandio: Use KBD for Energy.

Mr. Shams ul-Mulk: Let us understand the following:

1) We have a WAA (Water Apportionment Accord of March 1991). Each province must get its due share. The share from any **new** reservoir is clarified & agreed by four Chief Ministers ie: 37% for Punjab, 37% for Sindh, 14% for KP& 12% for Baluchistan.
2) KP presently gets less than 1.5MAF from the Indus Main. Sindh gets much more.
3) Only KBD can give KP Indus water. My land (KP) is about 100 ft to 150 ft high. If pumping is used the costs would be 10 to 20,000 per acre. Therefore gravity flow canals are the least cost solution. KBD makes this possible for the people of KP. Is it not correct that Sindh water abiana is about Rs150/acre?
4) USA made 6,575 large dams in the last century. Height is +15m. and other factors.

5) India has built 4,291 large dams and is making another 659 large dams. By 2025 India wants to build another 2500 dams for an additional 1800bn cubic meter storage. Compare this with Tarbela's initial 11bn cum storage capacity.
6) China made +22,000 dams and is still making more. They have to their credit the "Three Gorges Dam". They made many sacrifices as a nation for long term benefit.
7) Some 80% of the land erosion is observed in Asia between Pakistan & China because the Himalayas are a younger mountain system.
8) WAPDA was not involved in the IWT 1960. WAPDA became the agent (for its execution). Mangla was only a replacement reservoir.
9) The post-Tarbela route was decided in 1963 by FM Ayub Khan during his talks in 1963 (in USA) with World Bank president Mr. Eugene Black.
10) The World Bank initiated an Indus Special Study in 1963-67; "Development of Water & Power Resources of Pakistan – A sectorial analysis". The GoP wanted to know till what time the benefit streams will be valid. **The World Bank said only upto the 1980s. They advised that new storages must be started by 1977.** Punjab was not responsible for this decision.
11) Truth is available for all to observe & confirm. KBD was never based on lies but for national development & progress.
12) KBD does not aggravate the flood risk. Nowshera valley has an inherent problem. There is a gorge, inhibiting the combined Kabul & Swat rivers flow. The city is built on both sides of this gorge. Then there is the back pressure effect (under flood conditions) of the great Attock gorge downstream which inhibits the combined flow of the Indus & Kabul river flow creating a massive flood wave at Nowshera. A catastrophic event occurred in 1929 and the phenomenon was repeated as the floods of 2010.
13) Sindh gets +8MAF additional water due to Mangla & Tarbela. On what logic KBD would not provide more water to Sindh?
14) The 2010 flood level was 10 ft higher than the 1929 flood level (960 ft compared to 950 ft asl). The Kabul River was flowing over the new bridge at Nowshera.
15) KBD is regretfully blocked due to lies and disharmony amongst the provinces.

Mr. Shamshad Gohar: In 770 Hijri there were floods around Holy Kaba.

Dr. Bashir A. Chandio: The flow downstream Kotri should be 21 MAF.

Mr. Sardar M. Tariq: Please remember that 0.5mn tons of sand, silt & sediment are received at the Tarbela reservoir every day. It cannot be sluiced as there is no capacity to manage this quantum of sediment. If attempted it will choke all canals & downstream barrages. Tarbela reservoir has a finite life span. The river level was at 1100 ft asl when WAPDA started Tarbela construction in 1966. With silting its storage will diminish but the power generation will be available. The raised level will allow tremendous opportunities in diverting waters to other areas. This means more off-channel storages such as Dhok Pathan etc.

Begum Dr. Zaigham Habib: +40,000 dams were built in the last century.

Mr. Shams ul-Mulk: In the 20th century the world built 800,000 dams (all sizes) of which 45,000 are +15m.

Mr. Sardar M. Tariq: China has in fact 86,000 dams of which 24,000 are large dams. Tragically Pakistan has just 26 days storage (of its surface flows). China has +220 days and India has +120 days storage capability. Japan has built more than 3,000 dams primarily for its industrial development. In 1994 the DG Canal (thru Taunsa Barrage water) was given to Punjab. A big investigation was ordered by the Prime Minister. The President was the Chairman of the Cmte. Basically we don't trust each other. WAPDA had recommended that IRSA set up on extensive telemetry system to remove doubts & misgivings.

Suleman N. Khan: Sindh irrigation team under an XEN observing Punjab irrigation network have never reported a single violation / encroachment of the IRSA guidelines.

Mr. Khalid Mohtadullah: Building small dams is no solution. About 68 small dams were created upto +50 ft in the last 65 years excluding large dams (Mangla, Tarbela & Warsak). However these small dams do not give a single MW or do any flood protection. Their average capacity is 8500cft. There if you want to replace KBD we need 750 sites in the Northern Areas, KP and North Punjab. Pakistan needs large dams for Irrigation as well as Industry and drinking water needs. Large dams can also provide low cost electrical energy as well as provide inherent flood control.

Mr. Shams ul-Mulk: The price of not building KBD is to forego 12 bn units at around Rs1.20/KWhr. A bonus of over Rs180 bn per year. Compare the alternate cost of thermal power for 12 bn units per annum.

Dr. Bashir A. Chandio: However damage to Sindh biodiversity must be fixed? Intensive agriculture not extensive agriculture is better. The tail-ender has generally no water.

Suleman N. Khan: The World Bank had fully cleared KBD with the ISO 14000 studies of 1987.

Mr. Khalid Mohtadullah: The Bari-Doab Study funded by IMMI is very good.

Suleman N. Khan: Our water management expert Begum Dr. Zaigham Habib is of the opinion from her long observation of Sindh agriculture that the Sindh farmer generally has four times more irrigation water at the farm gate compared to the Central Punjab farmer. In Sindh the annual average is 2000mm compared to 500mm in Punjab. This is a key issue for the nation.

Mr. Sardar M. Tariq: There has been a 154.44 MAF average flow during the last years. Where is the water going?

Begum Dr. Zaigham Habib: Punjab &KP do not want the telemetry to work after the floods damaged it. In any case +40MAF additional was lost to the sea during the 2010 floods.

Suleman N. Khan: Pakistan has no institution that can keep track of the hydrological cycle and the additional flows due to global warming. India does not disclose the true IHK flow data, only fudged figures are intermittently received. Some estimated +56 MAF total flood loss in 2010. This includes global warming waters which are irreplaceable.

Mr. Khalid Mohtadullah: WAPDA should have maintained the integrity of the system. During the recent Tarbela 4th HPP Ext. studies it has been established that the canal withdrawals are now about 95MAF and not 104/105MAF previously recorded.

Suleman N. Khan: India is diverting our waters from its IHK infrastructure (presently exceeding 172 projects with over 44 in operation) on the Chenab, Jhelum & Indus Rivers. They are also completely mopping up the extra flows caused by global warming & glacier retreat.

Mr. Shams ul-Mulk: We should not have accepted Indian rights on our rivers in IHK under any pretext. Every river is a life source and impacts the culture of its command area. It provides drinking water and sustains life. Pakistan must strengthen the IWC (Indus Water Commission).

Mr. Sardar M. Tariq: Use available technologies to determine the real time data of IHK flows.

Mr. Khalid Mohtadullah: Indians say that 60% of the glaciers that feed the Jhelum are gone. Simply retreated / vanished. This could have serious repercussions.

Begum Dr. Zaigham Habib: Can we fully believe their claims?

Suleman N. Khan: The Indian Commissioner for Indus Water has available a fully fledged IWC andabove all

institutions such as the ICID & several others. Pakistanis are sleeping. Thousands of Indian hydrologists, scientists and engineers are observing every aspect of the Indian sub-continent's hydrological cycle since 1950 whereas Pakistan's IWC is virtually moribund; a tiny and listless office tucked away in a corner of Begum Road, Lahore. The sixth Commissioner since 1960 was taken in 2012 from NESPAK; has a few deputies drawn from Punjab Irrigation & WAPDA etc. It is a national tragedy and shows what Pakistan bureaucracy thinks of the water endowment. Incidentally the Punjab Irrigation retains an 86 years old civil engineer to serve as its eyes and ears on IWT 1960 and IRSA matters. Furthermore against all legal and even logical dictates the President of Pakistan has handed over effective control of both the IWC and IRSA to his friend Mr. Kamal Majidullah. The gentleman is reportedly a lawyer. Sindh is suffering from hydrological xenophobia in addition to its acute lower riparian neurosis.

Mr. Shams ul-Mulk: Only truth will bring us to the right decision on large dams. Why DI Khan and Bannu do not raise their voice for water. The provincial government of KP is ANP controlled with just 5.6% of the vote bank. Their interests in some regions of KP are minimal it seems. Due to the fact that dams are not available upstream; every 10 to 15 years the infrastructure of South Punjab and Sindh is destroyed by floods. In the world it is a struggle for Energy, Food & Water. In Pakistan water alone could solve the demand for all three. Let there be a perfect telemetry system for control & observation. Let me state that 10 MAF downstream Kotri is enough (to maintain the ecology). Drinking water must be catered for.

Begum Dr. Zaigham Habib: Satellite monitoring is also available. No one should look at short time gains. The integrity of the whole Indus Basin must be safe guarded on a sustainable basis. Bart Schulz thinks 5000 c/s around the year (3.65 MAF) & another 5 MAF for flood attenuation is sufficient for downstream flows below Kotri.

Mr. Sardar M. Tariq: Upto now we do not have a national water policy. No concept or understanding exists of a recharging system of our GW resource. Indians have even continued to divert from our aquifers by using massive pumping in Indian East Punjab.

Mr. Khalid Mohtadullah: No governance of Ground Water resource is a very serious situation.

Mr. Shams ul-Mulk: I recommend we withdraw all tube well subsidies. "The future cannot be predicted but can be prepared", was the profound statement of a Russian philosopher. Climate change is very serious. We have to understand what it implies. We have to understand the implications of extreme events; dry years, wet years etc.

Mr. Khalid Mohtadullah: Climate change is an un-exact science. Let's improve our resilience, our water management. The mantra should be water savings, water savings, water savings.

Mr. Shams ul-Mulk: Levies on Kabul River upto WARSAK should have been built. Munda dam could also protect Nowshera. Alternately we could dam the Chitral River. The Kabul River flow of 21 MAF has 14 MAF from Chitral, Swat & Dir Rivers. Before the Indians outflank us we need to go for a joint development of the Kabul River with Afghanistan. Let them have 2 to 3 MAF.

Suleman N. Khan: KBD operation for flood control was to be in tandem with Munda dam. It will provide valuable irrigation waters to areas of North KP while KBD to the areas of South KP. Munda dam is not a standalone project. It was always ranked lowest in the major studies.

Mr. Sardar M. Tariq: Diamer Basha dam must be built but with a lower height for safety reasons. Its existence will enhance the life of Tarbela (debris check) and it will permit +14,000 MW of downstream Run-of-River projects such as Dasu HPP, Thakot HPP & Pattan HPP. However it must be a safer design.

B-1 MINUTES / DELIBERATIONS OF 1st FORMAL MEETING 2015

Pakistan Economic Forum-III
Water Panel
Meeting 17 Feb 2015

Sub: Deliberations of the 1st formal meeting held on 17 Feb 2015 at Islamabad.

The meeting was attended by:

1. Dr. Hon. Shams ul-Mulk
2. Begum Dr. Zaigham Habib
3. Mr. Suleman Najib Khan

The meeting took place at Ramada Hotel Islamabad. Engr. Shams ul-Mulk and Begum Dr. Zaigham Habib participated. Sardar Tariq was visiting PEDO, Peshawar. Our member from Lahore, Mr. Gohar, was unwell. **The specific comments**:

Shams ul-Mulk: The interpretation of both parties, Pakistan and India are now vastly different. This is under a well thought out strategy. Normally rivers are divided but in this case sub-basins were divided. Furthermore:

1. Indian hydrological rights are supported by their territorial rights. Unfortunately Pakistan's hydrological rights are not supported by its territorial rights. It is like a revenue officer (Patwari) saying "Intiqal to ker Diya Magar Qabza Aap Khud Lay Lain". I have made you owner but you will have to take the possession. Only thing Pakistan could do was to take 'Qabza' but when we went to the World Bank, India had the Qabza (possession).
2. How do you divide the water flowing through someone else's area/territory? How do you establish your rights under these circumstances? There is issue of drinking water and canals for irrigation. However we had to establish our water rights. Pakistan could now go to the International Commission and ask for these dams to be demolished. All the dam structures built by India are in violation of the IWT 1960. No DAM is without storage.
3. Indians have acknowledged that 42 dams are ready in IHK. They have no right to sell its power to New Delhi and to the rest of the world. As a member of the Technical Committee (2003-2005) I had spoken for 70 minutes in front of President Gen. (R) Musharraf.
4. Remember when the English came they saw that in the sub-continent irrigation canals already existed. The Canals & Drainage Act 1887 (based on the Rawaj-i-Abpashi) gives all the rights to the Upper Riparian. It is clear that Punjab & KP provinces never used this right as upper riparians, clearly out of consideration for the sentiments of Sindh & Baluchistan. Hence my thesis of the "Great Betrayal". The conspiracies against KBD.
5. We need to understand all the "indirect development" options as well. Was blocking KBD not a great mistake and national tragedy? Flood irrigation is benefitting whom?

Zaigham Habib: It has only created too much water logging in Sindh. In reality they are mining saline water. They use drainage pumps and canals also for irrigation.

Suleman N. Khan: The Indians plan 28,000 MW in IJK. Mega projects on the Chenab such as Pakal Dal 1200 MW and Sawalkot 1500 MW have been tendered. Baglihar-II (450 MW) also on the Chenab is already under advance construction planning.

Shams ul-Mulk: While presenting the KBK/KDP project details to Wali Khan in the presence of Mr. Bashir Bilour the response was "even if KBD is gold we are not the buyers". KBD benefits to the small provinces would be enormous. Only in KP +800,000 Acres could be irrigated in the Bannu & Kohat districts. Remember Tarbela Dam storage is distributed as follows:

KP	4%
Baluchistan	6%
Punjab	20%
Sindh	70%

Infact Punjab and KP could take 60,000 c/s from Indus River because of Tarbela dam.

Suleman N. Khan: Mangla dam was only a Replacement Dam for the canals that were to become dry after the eastern rivers were given to India under the IWT 1960.

Shams ul-Mulk: Therefore WAPDA had compelled the World Bank to agree to a second reservoir on the Indus to meet the future needs of Pakistan. Tarbela reservoir could not meet the future needs.

Zaigham Habib: I can show the IRSA water distribution graphically.

Shams ul-Mulk: The Radcliffe award and the military occupation of IHK are having water control (by India) as the major motivating factor. Water loss below kotri is due to mismanagement by Sindh. The seawater intrusion is a tidal scenario and outside the IWT 1960 and the Indus basin system control.

Zaigham Habib: If flood canals are built then no dams are possible. IPCC reports are discussing even greater sea water rise for the coastline. There is similar data available from Indian and Chinese literature on Global Warming effects. In Pakistan it seems all the institutions are tired. No data is available. The Indus River is not being represented.

Suleman N. Khan: Mr. Ramaswami Iyer (Indian team leader) never acknowledged at Bangalore [Feb 2014] that Pakistan is water stressed. He and his associates kept on arguing that the IWT 1960 is a "Limited agreement and GW is not covered". My retort was that "you plan to use the excess power generation in IHK for pumping below the river valleys". Later in the session we saw their Prof. Shakeel Romshoo (Srinagar University) distribute his book to reinforce the Indian position on Global Warming and to negate the phenomenon of glacier retreat & related flooding. In August 2014 Prof. Romshoo was proven wrong as Srinagar was flooded.

B-2 MINUTES / DELIBERATIONS OF 2nd FORMAL MEETING 2015

Pakistan Economic Forum-III
Water Panel
Meeting 24 Feb 2015

Sub: Deliberations of the 2nd formal meeting held on 24 Feb 2015 at Karachi.

The meeting was attended by:

1. Mr. Suleman N. Khan
2. Dr. Bashir A. Chandio
3. Mr. Nadeem Iqbal (Artistic Milliners, Korangi)
4. Mr. Parvez Ghias (Indus Toyota)

The specific comments:

Nadeem Iqbal: We are the largest exporter of Denim fabrics & 3rd largest in garments. Presently we recycle our effluents using oxidation. About 30% water is already being recovered.

Dr. Chandio: Should cost PKR 0.10/gall instead of PKR 0.50/gallon charged by tankers?

Nadeem Iqbal: Brine is still a problem. It is the reject of RO plants. There are three stages of RO process in Artistic Milliners. We obtain three different drainage lines: hard-water for garden irrigation, solids to municipal waste and recycled process water.

- Hydrant water 2000/2500 TDS can be supplied by the tanker mafia. No water even at -3000 ft depth is available in Korangi area.
- Korangi in 2001 was having 1,200 TDS at -700 ft depth with output of 40,000 to 50,000 imp gall/bore/day. In 2014 water was 7,000 to 12,000 TDS at -3000 ft depth with output of 15,000 gall/24hr per bore.

Dr. Chandio: Riverine forests are necessary for fish Culture. It protects Pollution of maritime boundary. WAPDA had declared 1,000 TDS as 'A' grade (for irrigation).

Nadeem Iqbal: In our factory we also achieve the following:

1) Combined Cycle Heat Recovery on our DG sets exhaust. Also CO_2 recovery which is used for Beverages, Firefighting & Welding.
2) Factory roof is used for PV Solar.
3) Another 120,000 Sq. ft for bee farming.
4) Even cloth waste is recycled.
5) Pumps for water used are highly efficient.

Dr. Chandio: Is Arsenic coming from pesticides? Our rock is not having arsenic.

Nadeem Iqbal: RO Plant 150,000 Imp gall/day. Cost of RO membrane is $630. There will be 3 in parallel. Initially back-wash is sufficient to clean it.

Dr. Chandio: Keenjhar is also known as Kalri (fed by a Kotri Barrage Canal). Kathor (Malir) was once a source of GW. Lasbela is also a source of GW (rainwater recharged). Hub Dam is also a source. There should be a source of data on water. Include academicians & students.

Parvez Ghias: Funded a 5 year report on the environment. Research was carried out 24/7 at 5 major hospitals of Karachi. NED & Agha Khan were also involved. NDMA was involved.

P.S: Mr. Nadeem Iqbal was unable to provide a formal report on their factory's "green" activities. Hence the Panel Chairman visited the Gul Ahmad Textile Mills in Landhi Industrial area, a few km north of Korangi Industrial estate. At Gul Ahmad Mr. Salahuddin K.F. Rahman (Technical Director) spoke about their Mills "green credentials" in detail. Some specific comments of Mr. Rahman:

- Have 3 points for waste water pumping. At one location mining 1 MGD, about 1.5 km from the main plant.
- There are 3 locations where dyeing chemicals are used about 350 days a year. Both dyeing & printing creates problems for GW & otherwise. We have to strive to achieve the NQS (National Quality Standard) especially heavy metals to less than 1%.
- EPA has recently been active.
- Have a 1.5 MGD total waste water capability. Energy conservation also started due to expensive oil.
- Now due to water shortages the Industry will be compelled within 5 years to do recycling. The KWSB lines are leaking. Far more serious an issue than the Tanker Mafia who are supplying water mixed with brackish water.
- Gul Ahmad would like to recover 70% water within 3 years. The KWSB lines are sometimes damaged wilfully as well.
- Gul Ahmad is looking at several vendors. South India has "zero liquid discharge" policy. Also clients are demanding at-least 50% Recycling.
- Gul Ahmad self generation at these mills is 30 MW from three captive TPS.
- Some chemicals are not permissible.
- Chemical, physical & biological treatment results in activated sludge process. Presently no chemicals are used. Only using biological method to treat the sludge. The sludge is not thrown away although it biological sludge and not hazardous. It is duly covered & gathered in empty chemical bags for transportation to a specific storage area.

B-3 MINUTES / DELIBERATIONS OF 3rd FORMAL MEETING 2015

Pakistan Economic Forum-III
Water Panel
Meeting 06 March 2015

Sub: Deliberations of the 3rd formal meeting held on 06 March 2015 at Islamabad.

The meeting at Ramada Hotel was attended by:

1. Dr. Hon. Shams ul-Mulk
2. Mr. Sardar M. Tariq
3. Mr. Shamshad Gohar
4. Begum Dr. Zaigham Habib
5. Mr. Suleman Najib Khan

The specific comments:

Shams ul-Mulk: Ground Water & Environmental pollution (water & air) including the transboundary aquifers can be reversed if existing agreements are implemented. Otherwise we lose 50 years of work done. The underground (aquifer) mining in IHK is theft of our western waters and we must inform the WB & PCA. Now it has become necessary to approach the International Commission for Justice.

Sardar M. Tariq: We have to induce our own people. Take them on board.

Suleman N. Khan: Let us understand the pollution at all levels. Even the damage caused by plastic waste in the urban and rural areas.

Shams ul-Mulk: Let us remember that a large hydropower station averages about PKR 1.56 per unit (kwh). It could be lower for large dam.

Sardar M. Tariq: It was Mr. Benton who built the Benton tunnel in the Swat Valley. Upto 1921 former NWFP (now KP) was actually part of Punjab. The year was 1894. He brought the Welsh Coalminers who had tunnel experience. The lower Swat Valley was created. Its economy started to flourish as the tobacco trade was born. Secondly the sugarcane crop became plentiful. Mr. Isher Das founded the Mardan Sugar Mills. The “Bookha Khans” became “Gur Khans” thanks to the Swat river waters being diverted to the lower Swat Valley.

Zaigham Habib: In the next two years we must start KBD otherwise it will be too late.

Sardar M. Tariq: Do we understand the “benefit stream”. The real stakeholders must be represented in these fora. Why a USD 100 bn project for drinking water cannot be done? The PBC has to understand the benefit stream starting from the poorest project forest dwellers. Understand the water-sheds, the timber assets, the livestock assets, the forestry, the GW recharge etc. The poorest forest dwellers receive nothing as part of the benefit stream. The Sindh media groups including “Kavish” must be educated on the reality, the truths.

Shams ul-Mulk: Tell them the facts that there will be no water in winters after few years.

Suleman N. Khan: The concept of The Great Indus Cascade (2015-2040) will give winter flows but the KBD reservoir has to exist for flood control. We all agree to this.

Sardar M. Tariq: WAPDA was in a position to launch (in the 1990s) the KBD/KDP in an estimated amount of PKR 2 to 3 bn. All construction equipment was available. Suddenly the establishment got cold feet in 2000. Even today there are enough pension funds available to start it.

Suleman N. Khan: The IBIS & WAPDA hydro assets are around USD 1 Tr equivalent. They are unleveraged assets. Construction of the Great Indus Cascade will need to raise capital & debt from these assets as WAPDA's own balance sheet has been reduced to a pittance. The organization whose budget was PKR 2500 mn in 1969 when the Federal budget was PKR 1700 mn is now on life support and unable to build from its own resources the required dams & HPP projects. Look at the finances of this soon to be constructed DASU HPP. The WB has directed them to build 50% (two out of four power tunnels) which means 2150 MW in the first phase instead of 4300 MW. The main tenders ICB-MW-01 and ICB-MW-02 for DASU HPP are on commercial finance using the concept of World Bank Partial Credit Guarantees (PCG) whereby the World Bank will provide loan Repayment Guarantees for the Contractor's Supplier Credits.

Sardar M. Tariq: Has Sindh ever had winter crops?

Suleman N. Khan: We have to be very emphatic about our basin and understand it.

Sardar M. Tariq: After 2000 AD the water flow is -10 MAF. In the Tech Cmte report 154.88 MAF was agreed as average flow. Until the technocrats are inducted there will be chaos.

Shams ul-Mulk: Can we use the extra flow? We must never concede any point.All the waters" are for uninterrupted flow to Pakistan. Our rights nder the IWT1960. Today it is used for India. Did the WB not know that territory is not with Pakistan and the pressure will come on water flow?

1. People who lived for thousands of years (the locals) have the rights on these waters. The people of these 3 sub-basins not even all the people of IHK or the people of India.
2. However the other principle: Law is developed common sense. Exceptions do not negate the basic principle e.g: HPP in Kashmir are only for local sub-basins.
3. Even electricity generation. Is there any alternate energy source for IHK? The Eastern rivers gave them 33 MAF instead of 6 MAF historic share. First we have to fix our own-house. The IWT1960 in letter & spirit has to be respected. The Pk sub basin rights must be protected.

C-1 CIBSA our response to the ICID challenge; Global warming:

Pak Commissioner Indus Waters (PCIW) secretariat at Lahore deals with the cases related to the IWT 1960. The commission works under the overall control of the Federal Ministry of Water & Power. While the Indus River System Authority (IRSA) also works directly under the Federal Ministry of Water & Power and manages the distribution of Indus Basin Waters to the provinces. The inter-provincial water disputes became manageable after the signing of the Water Apportionment Accord (WAA) in March 1991 and the creation of IRSA as a result in 1992. However both PCIW & IRSA lack the required punch due to deficient technical depth & commitment. In the case of PCIW secretariat it is shamefully under-equipped to face a diabolical, merciless & relentless upper riparian neighbor. PCIW must not depend on Indian data. The Indians clearly worship a water-god as their actions have shown since 1946.Nehru created in 1950 an "International Commission for Irrigation & Drainage (ICID) that now serves hundreds of international clients & multi-lateral agencies. Reportedly +25,000 personnel work for ICID. What is most relevant is that they have the tools to analyze accurately the hydrologic cycle of the Indus Basin. In contrast our fifth PCIW (1991-2011) has repeatedly stated that he has no data /information of the inflows in IHK Rivers & streams. If the watershed in Kashmir is not understood how does Pakistan expect to face their aggression? Secondly every Indian move leading to attrition of water flows into Pakistan is blamed on the altar of "Global Warming". Glacier retreat is ongoing everywhere but this for the interim means more water in the rivers! This is clearly the rationale for the Northern River Linking project of India; a USD 212bn project launched in 2006 based on the Prabhu report of 1999? My face to face talks in New Delhi during end July 10 had compelled the Indian side to agree on a joint watershed study in IHK. How do we implement it if there is no organization in Pakistan to provide the expertise? Above all we need a motivated team that can face all the techno-legal issues around the IWT 1960 especially to neutralize Indian violations & transgressions. The tragic decision by the neutral expert on Baglihar-I is a contradiction of the basic spirit of the IWT 1960. If low level gates are permitted below the dead level under the pretext of "silt excluder" then who will ensure that these are not misused? A dangerous precedent that must be challenged because there is no monitoring of IHK hydro sites being no-go areas for Pakistan nationals. The creation of CIBSA is therefore overdue by at least 55 years which is the age of the IWT 1960. Let our hydrologists & scientists come forward to serve CIBSA. "CIBSA maybe our response to the ICID challenge".

C-2 IWA series; CIBSA our response to the ICID challenge

Water is our most important endowment. The alarming reduction in Indus Basin waters entering Pakistan are undeniable signs of an orchestrated policy by the Indian Authorities. The advice of Mohammad Ali Jinnah about Kashmir being the main life sustaining artery of Pakistan has now been finally appreciated by his countrymen. The Indians clearly understood the strategic value of Kashmir waters and manipulated the "accession" & defacto military occupation of the State of Jammu & Kashmir. They ensured their status as the upper riparian for Indus waters. Their actions defied common sense and the democratic values they propagate but for them "the ends justified the means". I estimate that it is the intention of the Indians to now squeeze at least 3MAF annually of our surface water flows in a sequential progression.

We have to be more perceptive and understand that the water resource is the cause of all our major internal frictions. The distrust between the provinces over Irrigation waters has pitted brother against brother. A result of Pakistan's failure to build the main reservoirs after Tarbela (1974) on its three western rivers; understood as its share of the Indus system in the Indus Waters Treaty of 1960. These proposed reservoirs were a critical element of the extended "replacement works" that would have kept the Ravi & Sutlej superficially alive through the "Link Canals" it had inherited as part of the IBIS (Indus Basin Irrigation System). Rivers sustain civilizations. What a mess we have created due to this atmosphere of distrust. Who to blame?

The anti-dam lobby became vocal first via the pro-Indian lobby of Walibagh, KP. Dams do not create floods they control floods. The 1929 Nowshera valley flooding was repeated in 2010. KBD does not exist. The anti KBD lobby including Chairman WAPDA now insist that if KBD had existed the damage would have been greater. All hydrologists understand that the Nowshera flooding is always caused by its location between the smaller Nowshera gorge & the longer Attock gorge. The KBD site being +100km downstream of the Attock gorge would have had no influence. In fact more dams would mean more regulation & flood control, especially downstream of the structure. With respect to the imaginary water logging of Mardan/Charsada & Peshawar valleys.How can capillary action of 40 ft be possible against all laws of physics? The lowest point of KP at 955ft asl is 40 ft higher than design of KBD max crest level at 915ft.Falsehood simply drowning out the truth.

The rise of the Sindh anti-dam lobby in retrospect gets visible after the birth of Bangladesh. The Indians put a successful formula to work and we again went to sleep. Since Sindh needs fresh water more desperately than Punjab. Sindh has negligible sweet water aquifers. It is the extra flow of the short flood/monsoon season that will be stored in the proposed KBD & other new reservoirs. This will allow the main rivers to be kept vibrant for the remaining 10 months. All these issues (external & internal) need a neutral & credible national organization operating under military discipline. Should hydrology & hydrologic issues remain in confusion? A joint civil-militiary effort is unavoidable.

I estimate that the Indian factor; its interference in our Indus Basin flows (directly & indirectly) has already inflicted a loss of over USD one trillion plus on Pakistan's nascent economy. This loss will now grow exponentially because the loss has snowballed into an energy crisis resulting in a catastrophe for our industry & agriculture. The Hydel to thermal ratio has become 30:70, ie: completely lopsided. Indus basin flows are having extreme variations; some years more than 33 times from minimum to maximum. Therefore an unavoidable element of 30% thermal energy was determined after great analysis. Having been frustrated in our attempts to develop more hydropower we became suicidal & starting in 1988 accelerating by 1992 & consummating by 1994 produced an IPP policy based primarily on imported energy that was hazardous & unsustainable. The IBIS an asset with replacement value, today, of more than USD 500bn is our prime national asset. We have not been able to optimize & utilize this vital gift. Our irrigated agriculture can be increased from 42mn acres to 63mn acres within 10 years. Triple cropping patterns will emerge when water is plentiful. Agro based industry would flourish. Let us jointly understand its potential to break the poverty cycle & enrich our coming generations. We may revive the TVA concept which is the basis of WAPDA but handover the Power Distribution/Discos to the provinces as per the 1973 Constitution. The IPP thermal private policy of 1994 based on the failed California model be capped as it is unsustainable. It has failed in California & also in Pakistan. Let us not forget that a very conservative estimate of our hydel potential is +65,000MW generating annually over 350bn units (350,000 GWh). This is more than triple of Pakistan's electric energy generation in 2011. Let CIBSA educate the nation about the "hydro truths". Pakistan incidentally has now less than 8% of storage capability of its 145MAF annual surface flow. The role of sweet water is central to Pakistan's financial sustainability &survival. It is blessed with five of the seven largest glaciers on the planet.

Global warming & the water bomb: Pakistan Commissioner Indus Waters (PCIW) secretariat at Lahore deals with the cases related to the Indus Waters Treaty (IWT 1960). The commission works under the overall control of the Federal Ministry of Water & Power at Islamabad. While the Indus River System Authority (IRSA) also works directly under the Federal Ministry of Water & Power and manages the distribution of Indus Basin Waters to the provinces. The inter-provincial water disputes became manageable after the signing of the Water Apportionment Accord (WAA) in March 1991 and the creation of IRSA as a result in 1992. However both PCIW & IRSA lack the required punch due to deficient technical depth & commitment. In the case of PCIW secretariat it is shamefully under-equipped to face a diabolical, merciless & relentless upper riparian neighbor. PCIW must not depend on Indian data. If you look deeper the direct Indian factor again emerges. The Indian organization "International Commission for Irrigation & Drainage" established in 1950 has developed an "India First" agenda and through guile & cunning positioned itself in a position of great influence with multilateral institutions

&government agencies worldwide. ICID is a dangerous weapon. Mr. Kamal Majidullah should have known,but it suited those who gave control of IWC between 2011-13 to his PATWO (NGO.)

The ICID now serves hundreds of international clients & even multi-lateral agencies. What is most relevant is that they have the tools to analyze accurately the hydrologic cycle of the Indus Basin. In contrast PCIW has constantly stated that he has no data or information of the inflows in IHK rivers& streams. If the watershed in Kashmir is not understood how does Pakistan expect to neutralize the Indian strategy? Secondly every Indian move leading to attrition of water flows into Pakistan is blamed on the altar of "Global Warming". Yes glacier retreat is ongoing everywhere but this for the interim means more water in the rivers! This is clearly the rationale for the Northern River Linking project of India; a USD 212bn project launched in 2006 based on the famous Prabhu report of 1999. Let CIBSA help us understand that global warming & glacier retreat is a reality. Where is the expected increase in the inflow of Jhelum & Chenab? Nearly 40MAF additionally for the next 30 to 40 years were estimated. India will never disclose this bonanza although not available till eternity. They declared their intention to install +28,000MW of Hydel capability in IHK. The exact water diversion in IHK needs a deep analysis.

Our Closed Door talks in New Delhi during end July 10 had resulted in the Indian side agreeing on a joint watershed study in IHK. How do we implement it if there is no organization in Pakistan to provide the expertise? We need a motivated team that can face all the techno-legal issues around the IWT 1960 especially to neutralize Indian violations & transgressions. The ridiculous decision by the Neutral Expert on Baglihar-Iis a contradiction of the basic spirit of the IWT 1960. If low level gates are permitted below the dead level under the pretext of silt excluder then who will ensure that these are not misused. A dangerous precedent that cannot be accepted. There is no monitoring of IHK hydro sites which are no-go areas for all outsiders. Can three bureaucrats or technocrats sitting in the PCIW Secretariat take on thousands in the ICID? The creation of CIBSA is therefore overdue by atleast 55 years which is the age of the IWT 1960. Let our engineers, scientists & technicians come forward to serve CIBSA.

Peace, not war, on the Indus

John Briscoe

The Indus Waters Treaty (IWT), signed by India and Pakistan in 1960 has been seen both as the one agreement that has worked between India and Pakistan and as an anachronism which should be dissolved or renegotiated.

On December 20, 2013 the Permanent Court of Arbitration issued a judgement which recalibrates and modernises the IWT, and again makes it a critical and effective instrument in avoiding conflicts between India and Pakistan on use of the rivers of the Indus Basin.

It is first useful to reiterate the central elements of the treaty and the long-standing areas of contention. The treaty assigns use of the eastern rivers (Ravi, Beas and Sutlej) to India and use of the western rivers (Chenab, Jhelum and Indus) to Pakistan. The biggest sticking point in negotiating the treaty in the 1950s was the conditions under which India could use the hydro-electric potential of the Chenab and the Jhelum before the rivers reached Pakistan.

The principle incorporated into the treaty was that indeed India could develop this potential, but only under a set of well-defined limitations on the amount of manipulable storage which could be created by India in the process, thus assuring Pakistan that India would not have the ability to manipulate either the timing or the quantities of the flows reaching Pakistan.

In the 1990s a difference arose about the Baglihar Dam being built by India on the Chenab. Pakistan claimed that low gates installed for flushing sediments violated the specifications of the treaty and endangered Pakistan's water security because it gave India a capacity to manipulate the timing of flows into Pakistan.

In 2005 a Neutral Expert was appointed to hear the case. His finding essentially said that new knowledge of sediment management technology meant that India had to be allowed to install low gates. His finding ignored the central balance in the treaty (between India's right to generate hydropower and Pakistan's right to unmanipulated flows).

Since India plans to build many other projects on the Chenab and Jhelum, if the Baglihar ruling established new ground rules this would, essentially, give India a free hand to do whatever it liked, leaving Pakistan vulnerable in both perception and practice. This was a recipe for growing conflict and, eventually, even war over the Indus.

In 2010 Pakistan took a new case, that of the Kishanganga hydroelectric project on the Jhelum river, to the International Court of Arbitration. On December 20 2013 the court issued its final judgement http://www.pca-cpa.org/showpage.asp?pag_id=1392).

The Kishanganga case comprised two elements – was India within its rights to build the project and was India able to insert low gates?

On the first, limited and specific issue, a specific annex to the treaty covered exactly this case. The key question was whether the Indian project would affect existing hydropower or agricultural uses downstream in Pakistan. Pakistan had long planned to build a similar project – the Neelum Jhelum project – downstream. But there was no doubt that this plan did not constitute an exist-

The brilliant work of the PCA should mean a new dawn for water management in the Indus. Rumblings over 'water wars on the Indus' should end

ing use and thus, in my opinion and that of most neutral parties, the court interpreted the treaty literally and accurately and allowed India to proceed.

While this will reduce the yield of the now under-construction Neelum-Jhelum project by a reported 10 percent this is a one-off, not systemic issue. The big and systemic issue was the second. Here the court reinforced the hard constraints built into the IWT regarding the ability of India to embed manipulable storage into this and all future projects. The court pointed out that while it might be convenient for India to build low gates in order to plush sediments, this was not the only way to manage sediments, and that convenience for India had to be balanced by the threat this would pose to Pakistan's water security. The court explicitly stated that the Baglihar ruling did not constitute a precedent, and implied that the Baglihar Neutral Expert had erred by not balancing engineering concerns with the diplomatic and security factors which were the heart of the IWT.

The decision by the PCA means that India can, as laid out by the IWT, continue to develop much-needed hydropower projects on the Chenab and the Jhelum, but it must strictly respect the IWT-defined limits on manipulable storage, and must use methods other than the construction of low gates to flush silt.

The court also played close attention to an area that had been neglected in the original IWT, namely environmental flows. The court mandated a small, constant release of nine cubic metres per second. This is less than the amount Pakistan claimed to be necessary, but more than the amount argued for by India. This flow will somewhat reduce the power generated by the Kishanganga project, reportedly by about 10 percent.

Again the court underlined the importance of balance. "Although the Court considered this approach (to defining the environmental flow) to be somewhat severe in environmental terms, the Court concluded that…such an approach represents an appropriate balance between the needs of the environment and India's right to power generation".

This principle of balance and reasonableness is particularly important because it is inevitable that Pakistan will ask that India release environmental flows from the eastern rivers (especially the Ravi and the Sutlej) into areas of Pakistan which have suffered major environmental damage as India has diverted all flows to the east.

As with the original Indus Waters Treaty there are critics on both sides who believe that their views are the only ones that should be taken into consideration and who see any compromise as capitulation. It is worth recalling the wise words of then president of Pakistan Ayub Khan, when the IWT was signed. "Very often the best is the enemy of the good, and in this case we have accepted the good after careful and realistic appreciation of our entire overall situation. The basis of this agreement is realism and pragmatism…"

The bottom line is that the brilliant and balanced work of the PCA should mean a new dawn for water management in the Indus. Rumblings over "water wars on the Indus" should now dissipate, and, once again, relationships between India and Pakistan on the Indus should become stable and perhaps even have a positive ripple effect on broader relationships between the countries.

The writer is a professor at Harvard University and has served as Senior Water Adviser for the World Bank in New Delhi.

War or peace on the Indus?

John Briscoe
Saturday, April 03, 2010

Anyone foolish enough to write on war or peace in the Indus needs to first banish a set of immediate suspicions. I am neither Indian nor -Pakistani. I am a South African who has worked on water issues in the subcontinent for 35 years and who has lived in Bangladesh (in the 1970s) and Delhi (in the 2000s). In 2006 I published, with fine Indian colleagues, an Oxford University Press book titled India's Water Economy: Facing a Turbulent Future and, with fine Pakistani colleagues, one titled Pakistan's Water Economy: Running Dry.

I was the Senior Water Advisor for the World Bank who dealt with the appointment of the Neutral Expert on the Baglihar case. My last assignment at the World Bank (relevant, as described later) was as Country Director for Brazil. I am now a mere university professor, and speak in the name of no one but myself.

I have deep affection for the people of both India and Pakistan, and am dismayed by what I see as a looming train wreck on the Indus, with disastrous consequences for both countries. I will outline why there is no objective conflict of interests between the countries over the waters of the Indus Basin, make some observations of the need for a change in public discourse, and suggest how the drivers of the train can put on the brakes before it is too late.

Is there an inherent conflict between India and Pakistan?

The simple answer is no. The Indus Waters Treaty allocates the water of the three western rivers to Pakistan, but allows India to tap the considerable hydropower potential of the Chenab and Jhelum before the rivers enter Pakistan.

The qualification is that this use of hydropower is not to affect either the quantity of water reaching Pakistan or to interfere with the natural timing of those flows. Since hydropower does not consume water, the only issue is timing. And timing is a very big issue, because agriculture in the Pakistani plains depends not only on how much water comes, but that it comes in critical periods during the planting season. The reality is that India could tap virtually all of the available power without negatively affecting the timing of flows to which Pakistan is entitled.

Is the Indus Treaty a stable basis for cooperation?

If Pakistan and India had normal, trustful relations, there would be a mutually-verified monitoring process which would assure that there is no change in the flows going into Pakistan. (In an even more ideal world, India could increase low-flows during the critical planting season, with significant benefit to Pakistani farmers and with very small impacts on power generation in India.) Because the relationship was not normal when the treaty was negotiated, Pakistan would agree only if limitations on India's capacity to manipulate the timing of flows was hardwired into the treaty. This was done by limiting the amount of "live storage" (the storage that matters for changing the timing of flows) in each and every hydropower dam that India would construct on the two rivers.

While this made sense given knowledge in 1960, over time it became clear that this restriction gave rise to a major problem. The physical restrictions meant that gates for flushing silt out of the dams could not be built, thus ensuring that any dam in India would rapidly fill with the silt pouring off the young Himalayas.

This was a critical issue at stake in the Baglihar case. Pakistan (reasonably) said that the gates being installed were in violation of the specifications of the treaty. India (equally reasonably) argued that it would be wrong to build a dam knowing it would soon fill with silt. The finding of the Neutral Expert was essentially a reinterpretation of the Treaty, saying that the physical limitations no longer made sense. While the finding was reasonable in the case of Baglihar, it left Pakistan without the mechanism – limited live storage – which was its only (albeit weak) protection against upstream manipulation of flows in India. This vulnerability was driven home when India chose to fill Baglihar exactly at the time when it would impose maximum harm on farmers in downstream Pakistan.

If Baglihar was the only dam being built by India on the Chenab and Jhelum, this would be a limited problem. But following Baglihar is a veritable caravan of Indian projects – Kishanganga, Sawalkot, Pakuldul, Bursar, Dal Huste, Gyspa… The cumulative live storage will be large, giving India an unquestioned capacity to have major impact on the timing of flows into Pakistan. (Using Baglihar as a reference, simple back-of-the-envelope calculations, suggest that once it has constructed all of the planned hydropower plants on the Chenab, India will have an ability to effect major damage on Pakistan. First, there is the one-time effect of filling the new dams. If done during the wet season this would have little effect on Pakistan. But if done during the critical low-flow period, there would be a large one-time effect (as was the case when India filled Baglihar). Second, there is the permanent threat which would be a consequence of substantial cumulative live storage which could store about one month's worth of low-season flow on the Chenab. If, God forbid, India so chose, it could use this cumulative live storage to impose major reductions on water availability in Pakistan during the critical planting season.

Views on "the water problem" from both sides of the border and the role of the press

Living in Delhi and working in both India and Pakistan, I was struck by a paradox. One country was a vigorous democracy, the other a military regime. But whereas an important part of the Pakistani press regularly reported India's views on the water issue in an objective way, the Indian press never did the same. I never saw a report which gave Indian readers a factual description of the enormous vulnerability of Pakistan, of the way in which India had socked it to Pakistan when filling Baglihar. How could this be, I asked? Because, a journalist colleague in Delhi told me, "when it comes to Kashmir – and the Indus Treaty is considered an integral part of Kashmir -- the ministry of external affairs instructs newspapers on what they can and cannot say, and often tells them explicitly what it is they are to say."

This apparently remains the case. In the context of the recent talks between India and Pakistan I read, in Boston, the electronic reports on the disagreement about "the water issue" in The Times of India, The Hindustan Times, The Hindu, The Indian Express and The Economic Times. (Respectively, http://timesofindia.indiatimes.com/india/Water-Pakistans-diversionary-tactic-/articleshow/5609099.cms, http://beta.thehindu.com/news/national/ article112388.ece, http://www.hindustantimes.com/News-Feed/india/River-waters-The-next-testing-ground/Article1-512190.aspx, http://www.indianexpress.com/news/Pak-heats-up-water-sharing/583733, http://economictimes.indiatimes.com/news/politics/nation/Pak-takes-water-route-to-attack-India/articleshow/5665516.cms.)

Taken together, these reports make astounding reading. Not only was the message the same in each case ("no real issue, just Pakistani shenanigans"), but the arguments were the same, the numbers were the same and the phrases were the same. And in all cases the source was "analysts" and "experts" -- in not one case was the reader informed that this was reporting an official position of the Government of India.

Equally depressing is my repeated experience – most recently at a major international meeting of strategic security institutions in Delhi – that even the most liberal and enlightened of Indian analysts (many of whom are friends who I greatly respect) seem constitutionally incapable of seeing the great vulnerability and legitimate concern of Pakistan (which is obvious and objective to an outsider).

A way forward

This is a very uneven playing field. The regional hegemon is the upper riparian and has all the cards in its hands. This asymmetry means that it is India that is driving the train, and that change must start in India. In my view, four things need to be done.

First, there must be some courageous and open-minded Indians – in government or out – who will stand up and explain to the public why this is not just an issue for Pakistan, but why it is an existential issue for Pakistan.

Second, there must be leadership from the Government of India. Here I am struck by the stark difference between the behaviour of India and that of its fellow BRIC – Brazil, the regional hegemon in Latin America.

Brazil and Paraguay have a binding agreement on their rights and responsibilities on the massive Itaipu Binacional Hydropower Project. The proceeds, which are of enormous importance to small Paraguay, played a politicised, polemical anti-Brazilian part in the recent presidential election in Paraguay. Similarly, Brazil's and Bolivia's binding agreement on gas also became part of an anti-Brazil presidential campaign theme.

The public and press in Brazil bayed for blood and insisted that Bolivia and Paraguay be made to pay. So what did President Luis Inacio Lula da Silva do? "Look," he said to his irate countrymen, "these are poor countries, and these are huge issues for them. They are our brothers. Yes, we are in our legal rights to be harsh with them, but we are going to show understanding and generosity, and so I am unilaterally doubling (in the case of Paraguay) and tripling (in the case of Bolivia) the payments we make to them. Brazil is a big country and a relatively rich one, so this will do a lot for them and won't harm us much." India could, and should, in my view, similarly make the effort to see it from its neighbour's point of view, and should show the generosity of spirit which is an integral part of being a truly great power and good neighbour.

Third, this should translate into an invitation to Pakistan to explore ways in which the principles of the Indus Waters Treaty could be respected, while providing a win for Pakistan (assurance on their flows) and a win for India (reducing the chronic legal uncertainty which vexes every Indian project on the Chenab or Jhelum). With good will there are multiple ways in which the treaty could be maintained but reinterpreted so that both countries could win.

Fourth, discussions on the Indus waters should be de-linked from both historic grievances and from the other Kashmir-related issues. Again, it is a sign of statesmanship, not weakness, to acknowledge the past and then move beyond it. This is personal for me, as someone of Irish origin. Conor Cruise O'Brien once remarked, "Santayana said that those who did not learn their history would be condemned to repeat it; in the case of Ireland we have learned our history so well that we are condemned to repeat it, again and again."

And finally, as a South African I am acutely aware that Nelson Mandela, after 27 years in prison, chose not to settle scores but to look forward and construct a better future, for all the people of his country and mine. Who will be the Indian Mandela who will do this – for the benefit of Pakistanis and Indians – on the Indus?

The writer is the Gordon McKay Professor of Environmental Engineering, Harvard University. Email: jbriscoe@seas. harvard.edu

Primer - 14

IN THE MATTER OF
THE INDUS WATERS KISHENGANGA ARBITRATION

-before-

THE COURT OF ARBITRATION CONSTITUTED
IN ACCORDANCE WITH THE INDUS WATERS TREATY 1960
BETWEEN THE GOVERNMENT OF INDIA
AND THE GOVERNMENT OF PAKISTAN
SIGNED ON 19 SEPTEMBER 1960

-between-

THE ISLAMIC REPUBLIC OF PAKISTAN

-and-

THE REPUBLIC OF INDIA

PARTIAL AWARD

COURT OF ARBITRATION:

Judge Stephen M. Schwebel (Chairman)
Sir Franklin Berman KCMG QC
Professor Howard S. Wheater FREng
Professor Lucius Caflisch
Professor Jan Paulsson
Judge Bruno Simma
H.E. Judge Peter Tomka

SECRETARIAT:

The Permanent Court of Arbitration

18 February 2013

PK-IN 82842

V. DECISION

Having considered the Parties' written and oral submissions, the Court of Arbitration unanimously decides:

A. In relation to the First Dispute,

(1) The Kishenganga Hydro-Electric Project, as described to the Court by India, constitutes a Run-of-River Plant for the purpose of Paragraph 15 of Annexure D to the Indus Waters Treaty, and in particular sub-paragraph (iii) thereof.

(2) India may accordingly divert water from the Kishenganga/Neelum River for power generation by the Kishenganga Hydro-Electric Plant and may deliver the water released below the power station into the Bonar Nallah.

(3) India is however under an obligation to construct and operate the Kishenganga Hydro-Electric Plant in such a way as to maintain a minimum flow of water in the Kishenganga/Neelum River, at a rate to be determined by the Court in a Final Award.

B. In relation to the Second Dispute,

(1) Except in the case of an unforeseen emergency, the Treaty does not permit reduction below Dead Storage Level of the water level in the reservoirs of Run-of-River Plants on the Western Rivers.

(2) The accumulation of sediment in the reservoir of a Run-of-River Plant on the Western Rivers does not constitute an unforeseen emergency that would permit the depletion of the reservoir below Dead Storage Level for drawdown flushing purposes.

(3) Accordingly, India may not employ drawdown flushing at the reservoir of the Kishenganga Hydro-Electric Plant to an extent that would entail depletion of the reservoir below Dead Storage Level.

(4) Paragraphs B(1) and B(2) above do not apply to Run-of-River Plants that are in operation on the date of issuance of this Partial Award. Likewise, Paragraphs B(1) and B(2) do not apply to Run-of-River Plants already under construction on the date of issuance of this Partial Award, the design of which, having been duly communicated by India under the provisions of Annexure D, had not been objected to by Pakistan as provided for in Annexure D.

C. This Partial Award imposes no further restrictions on the construction and operation of the Kishenganga Hydro-Electric Plant, which remain subject to the provisions of the Treaty as interpreted in this Partial Award.

D. To enable the Court to determine the minimum flow of water in the Kishenganga/Neelum River referred to in paragraph A(3) above, the Parties are required to submit to the Court the information specified in paragraphs 458 to 462 within the time periods set out in paragraph 463 of this Partial Award.

E. The interim measures indicated by the Court in its 23 September 2011 *Order on the Interim Measures Application of Pakistan dated June 6, 2011* are hereby lifted.

F. The costs of the proceedings to be awarded by the Court pursuant to Paragraph 26 of Annexure G to the Treaty shall be determined in the Court's Final Award.

Done at the Peace Palace, The Hague
Dated: February 18, 2013

Professor Lucius Caflisch

Professor Jan Paulsson

Judge Bruno Simma

H.E. Judge Peter Tomka

Professor Howard S. Wheater FREng

Sir Franklin Berman KCMG QC

Judge Stephen M. Schwebel
Chairman

Mr. Aloysius Llamzon
Registrar

IN THE MATTER OF
THE INDUS WATERS KISHENGANGA ARBITRATION

-before-

THE COURT OF ARBITRATION CONSTITUTED IN ACCORDANCE WITH THE INDUS WATERS TREATY 1960 BETWEEN THE GOVERNMENT OF INDIA AND THE GOVERNMENT OF PAKISTAN SIGNED ON 19 SEPTEMBER 1960

-between-

THE ISLAMIC REPUBLIC OF PAKISTAN

-and-

THE REPUBLIC OF INDIA

FINAL AWARD

COURT OF ARBITRATION:

Judge Stephen M. Schwebel (Chairman)
Sir Franklin Berman KCMG QC
Professor Howard S. Wheater FREng
Professor Lucius Caflisch
Professor Jan Paulsson
Judge Bruno Simma
H.E. Judge Peter Tomka

SECRETARIAT:

The Permanent Court of Arbitration

20 December 2013

DECISION

Having considered the Parties' submissions, the Court of Arbitration unanimously decides:

A. In the operation of the KHEP:

(1) Subject to paragraph (2) below, India shall release a minimum flow of 9 cumecs into the Kishenganga/Neelum River below the KHEP at all times at which the daily average flow in the Kishenganga/Neelum River immediately upstream of the KHEP meets or exceeds 9 cumecs.

(2) At any time at which the daily average flow in the Kishenganga/Neelum River immediately upstream of the KHEP is less than 9 cumecs, India shall release 100 percent of the daily average flow immediately upstream of the KHEP into the Kishenganga/Neelum River below the KHEP.

B. Beginning 7 years after the diversion of water from the Kishenganga/Neelum River for power generation by the KHEP, either Party may seek reconsideration of the minimum flow in paragraph (A) above through the Permanent Indus Commission and the mechanisms of the Treaty.

C. This Final Award imposes no further restrictions on the operation of the KHEP, which remains subject to the provisions of the Treaty as interpreted in this Final Award and in the Court's *Partial Award*.

D. Each Party shall bear its own costs. The costs of the Court will be shared equally by the Parties.

Done at the Peace Palace, The Hague
Dated: 20 DECEMBER 2013

Professor Lucius Caflisch

Professor Jan Paulsson

Judge Bruno Simma

H.E. Judge Peter Tomka

Professor Howard S. Wheater FREng

Sir Franklin Berman KCMG QC

Judge Stephen M. Schwebel
Chairman

Dr. Aloysius Llamzon
Registrar

ABSTRACT OF THE GREAT INDUS CASCADE (2015 – 2040)

It has become imperative to focus on a hydro strategy on the Indus Main for the long to medium term growth & prosperity of the nation. Pakistan lost the perennial flows of the so called three eastern rivers Ravi, Sutlej and Beas as a result of the IWT1960; preceded by serious arm-twisting by the upper riparian immediately after 1947. The often discussed Indus Cascade has different combinations but our panel hydrologists present the concept of The Great Indus Cascade for analysis & consideration. Indus river potential be viewed with respect to cascading impact rather then individual project impact.

- At present the northern most infrastructure envisaged would be Shyok Dam on the Shyok river. A 190 m structure resulting in 8 MAF gross storage with 5 MAF live storage. The dead storage of 3 MAF could provide +100 years sediment free operation for Bunji HPP and other downstream projects. Its power generation capacity around 640 MW capable of 3,750 GWh annual electric energy.
- The Skardu Dam downstream of the confluence of the Shyok and Indus rivers with a height of 120 m from river bed resulting in gross storage of 4.4 MAF with 3.2 MAF live storage. Its power generation of 1200 MW capable of 5,500 GWh annual electric energy. The storage at Skardu would trap sediment of Indus River in addition to regulation of flow for downstream HPP's.
- Bunji HPP a 7200 MW tunnel project to use 20 turbines of 360 MW each. Due to heavy sedimentation large number of turbines are proposed. The energy output is estimated as 24,000 GWh at 39% plant utilization factor. Conjunctive use with Shyok & Skardu Dams would provide tremendous benefits to downstream projects. Shyok & Skardu make possible a critical reduction of sediment at Bunji HPP.
- Raikot HPP. This Project upstream of a "reduced height" DBD is proposed with a 110 m structure and capable of 1800 MW power rating. Reduction of DBD height is a pre-condition of this project.
- DBD is proposed as a lower and safer dam at the present alignment with a structure height of 200 m above river bed (approximately 249 m above rock bed). It will be capable of 3400 MW and provide 15,000 GWh annual electric energy. The reduced height also permits the upstream Raikot HPP and fully off-sets the loss of electrical energy due to the 1,000 MW reduced power capacity of a lower DBD. By building a lower / safer structure the DBD design can shift from the lighter RCC (Roller Compact Concrete with protective plastic membrane) to a heavier more stable CFRD (Concrete Faced Rock-fill Dam) structure. DBD + Raikot HPP cascade is a superior, safer, least cost solution. The Design Review of DBD must be carried out by the Phase-III, construction consultants to be inducted. The consultants who were involved in Phase-I (Feasibility) and Phase-II (Detailed Design) be now ignored for Phase-III.
- Dasu HPP is a run-of-river project where the detailed design has been completed by a JV led by Nippon Koei of Japan & Dolsar, Turkey etc. Project is capable of 4,300 MW power base but due to financial constraints it is presently to have 2,150 MW by constructing 2 of the 4 power tunnels. The energy output being 21,300GWh annually with full power rating of 4,300 MW. We may not forget that full energy output of Dasu HPP is possible when DBD is available as an upstream hydraulic regulator. Sand/silt/sediment excluder function is another vital role of the DBD Reservoir for the downstream HPP projects; Dasu, Pattan, Thakot. However Dasu HPP commissioning will result in serious water shotage at Tarbela T-4.
- Pattan HPP is envisaged as a 2,400 MW project capable of 12,600 GWh annual energy output. Providing peak power at cheap tariff to the National Grid.
- Thakot HPP further downstream of Pattan HPP is envisaged as a 4,500 MW project capable of providing 22,000 GWh annual energy output with new cascading project layout.
- Tarbela Dam HPP Extension using Tunnel 4 (T-4). This project was conceived by NESPAK & Chas T. Main in October 1991 with two turbines rated 480 MW each. The calculated energy being 1900 GWH per annum (1.9 bn units) utilizing water surplus to tunnels 1, 2, & 3. Capable of additional peaking capacity of 300 MW during the October / June period. The proposed 480 MW turbines would be identical to the existing 4 turbines of tunnel No. 3 but using generators of higher capacity. The significant aspect being the May / June hydro head of 275/325 ft. which are no longer available after 42 years. It is well known that the Tarbela reservoir dead level is now 1,380 ft. asl. Since the maximum conservation level of Tarbela Dam being 1550 ft. asl, this project will be seriously limited in its output. The consultants MMI & CEB JV has configured in 2011/12 a power station (with 3 turbines) capable of 1410 MW & energy 2,300 GWh. It is a parody of the original Inception report by NESPAK & C.T. Main in

1991 when the lower dead level of Tarbela permitted greater discharge at higher head. This project is clearly assuming that existing hydro units on tunnels 1 & 2 will be shut off during several periods of the year including May & June. The increase of plant capacity from proposed 960 MW to 1410 MW seems to have no hydrological justification. The nation has to remember that due to the critical sediment sluicing requirement / capability of tunnel 4 its 1410 MW power plant will need to be periodically closed to allow sediment sluicing. The stage-wise upgradation of the 10 hydro-electric units on power tunnels 1 & 2 do not justify a surgical operation of totally shutting down power tunnels 1 & 2 at any time. It is an irresponsible design by MMI / CEB. The net effect of the upstream Indus Cascade projects is ignored.

- Tarbela Dam HPP Extension using Tunnel 5 (T-5). Reliable reports indicate that without due investigations and a bankable Feasibility this project is also being pushed by the incumbent T-4 Consultants mobilized at Tarbela Dam. It would be a national calamity and economic loss if T-5 is constructed merely to project MW basis when there is no additional energy possible. In fact after the construction of DBD there will be even no possibility to fully operate T-4. The use of T-5 for power generation means that Akhori off-channel storage is dead. Akhori is the logical backup reservoir to Tarbela. The irrigation aspects of Tarbela Dam (the sole reservoir on the Indus) has the logical priority.

- The KBD / KDP project was always the most reliable and prolific project on the Indus Main. Being at the point of maximum flow of the Indus Main it is not a high dam being only 260 ft. above river bed. It is the ideal point to regulate rainwater below the Potohar and accepted in all studies as the best storage for flood control. No other reservoir site is available to store & regulate flood waters of Kohat Koi, Kabul River, Swat River, Soan River etc downstream of Tarbela. A +100 years reservoir which means a non-silting storage. It will always be smaller than Tarbela in terms of capacity and electrical energy output. It has the inherent quality to be able to provide gravity flow canals to KP once the reservoir level is above 850 ft. asl. The maximum conservation level being 915 ft. asl. for the two monsoon / flood months. This level remains much below the KP valleys upstream and for this reason the ISO 14000 studies of 1987 conducted by the World Bank cleared the project from all environmental factors. The power basis of 3,600 MW being capable of providing 13,000 GWh annual electric energy from a mid country location. KBD would also channelise the Indus and allow inland navigation. Literally an inland port is created. KBD has no tunnels only diversion channels during construction. South of Taunsa the Indus would be coordinated and result in reduction of seepage & evaporation due to channelization/ narrow width. KBD has enormous benefits for the economy & provides great safety for downstream barrages on the Indus.

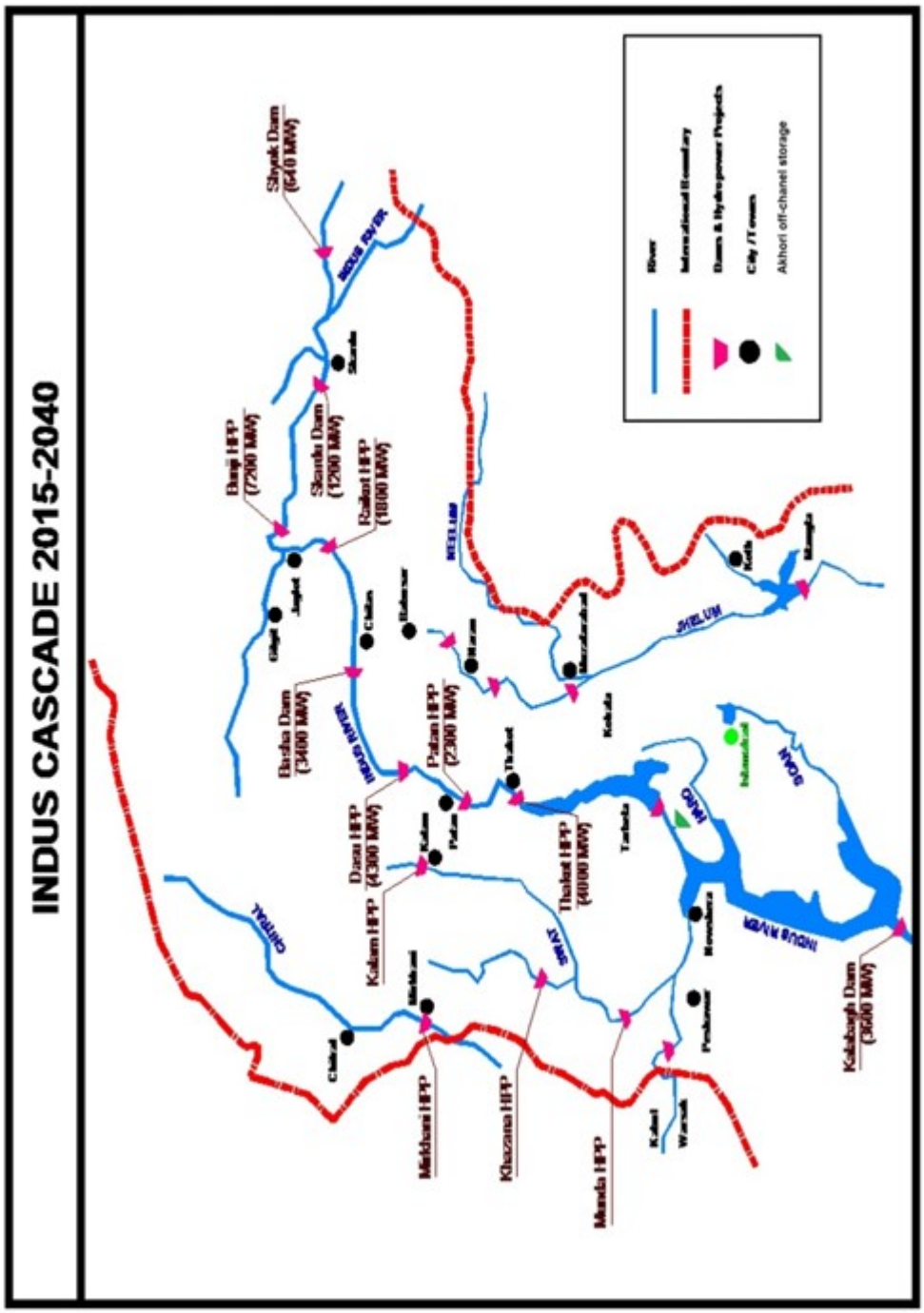
NOTE:

The Great Indus Cascade will allow 30,370 MW capacity from Shyok, Skardu, Bunji HPP, Raikot HPP, DBD, Dasu HPP, Pattan HPP, Thakot HPP, T-4 and KBD to deliver 127,000 GWh. With both Shyok and Skardu Dams the winter flows will become reliable. There will be 12 months regulated flow / debris free of the Indus Main. Tarbela presently receiving 400 to 500 cumecs minimum flow will receive 800 to 1,000 cumecs as a result of the Cascade. However the additional capacity of the T-5 is only during flood season before DBD is available. At the time of updating our report in Aug 2018 we hear that as apprehended that T-4 has suffered heavy sedimentation from the “delta”. As a result the T-4 power generation is shut-off. It is now a threat to Tarbela’s entire generation. A controversial project has become a national shame. There’s no scope for further experimentation at Tarbela.

After DBD there will be regulated water flows at Tarbela. Upto 1800 GWh additional energy will be available at Tarbela. However Tarbela T-5 is absolutely determined as a wasteful project without any net energy gain. It is an attempt to ignore the Akhori off-channel storage. A denial of the cruel reality that a replacement reservoir for the fast silting Tarbela reservoir is desperately needed. The downstream Akhori off-channel storage is indispensable. It is abundantly clear that the anti KBD lobby is equally opposed to the Akhori off-channel storage or any other reservoir project on the Indus. They agreed to DBD because it will have no off-take irrigation canals. Tragic.

In 2018 Neelum Jhelum HPP tunnel project is finally commissioned. However at +USD 5.5Bn cost for a seasonal 969MW it is the world’s most expensive HPP.The power house should have been on the upper Jhelum stem. The tunnel system as per original design could have been built in a few years at 25% cost. Arbitrary changes in design seem to have one clear purpose; increase the construction time & cost. The nation must wakeup now and not allow anyone to again milk this nation on energy projects. The race with Kishen-Ganga HPP was lost by our IWC as they failed to react inline wth IWT 1960 to the first Indian announcement. Details in Chap 16 & Annex E.

The cascading impact of projects on Indus river can provide power to National grid at plant factor of more than 60%. This impact is to be realized rather to focus on the individual project impact.



30,370 MW power capacity capable of 127,000 GWh