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KALABAGH - A SUPERIOR DAM DESIGNERS' VIEW POINT

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SUMMARY

Due to rise in Pakistan's population, pressure on its water resources is building up to meet the food and fiber needs. Severe water shortages, including distributional inequality in critical crop demand periods and on-going sizeable reduction in the storage capacity of Mangla, Tarbela & Chashma reservoirs are the critical existing problems of our irrigated agriculture. In order to save available water which now goes waste into Sea, thus bringing it to use, water reservoirs shall have to be increased.

The energy crisis in Pakistan is not only badly affecting the Country's economic growth, it is also paralyzing life in both the rural and urban areas because of long hours of load shedding. Had the policymakers paid heed to the generation of hydel energy from Kalabagh Dam Project, Pakistan would not today be facing such an energy crisis.

Kalabagh Dam Project is planned to utilize surplus water of the river Indus including its major tributary Kabul. It has been one of the most investigated projects in the World. Work on the planning of this dam was started in the year 1953. Since then it has been subjected to comprehensive and exhaustive engineering studies and explorations. Its feasibility has been confirmed by several independent consultants' firms of International standing at various times. A number of technical committees consisting of Pakistan and World famous technical experts were constituted at different times, to evaluate the project for its feasibility and its overall impact on the national economy, environment, water uses etc. The reviews of all these committees are highly supportive of the project. Detailed designs and contract documents were ready by 1988. World Bank and some other international agencies had agreed to finance the project. However, before the project could be launched, it started facing opposition from some of the provinces on account of their fears, reservations, and apprehensions real or unreal regarding its adverse impacts in some areas. Kalabagh Dam Project has been in the national focus for the last several years. Never has a project generated a national debate on such a wide scale. This is indicative of the importance of Kalabagh Dam Project, which would be one of the largest public works in Pakistan's history, and one of the largest multipurpose dams in the World.

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Kalabagh Dam Project is a far superior project than Diamer Basha Dam Project which is based on consensus of all the Provinces has recently been approved for construction. This Paper in para 2 illustrates many features in which Kalabagh Dam is superior to Diamer Basha Dam according to an independent assessment of the two Projects and their potentials to help accelerate Pakistan's economic development. Among other things, Diamer Basha Dam is a high cost project as it involves relocation of submerged Karakoram Highway and the construction of Power Transmission lines through the mountainous area to upto the Indus Plains.

This paper presents the picture of Pakistan as a Water deficient Country, superiority of Kalabagh Dam over Diamer Basha Dam, the power potential of Kalabagh Dam and some suggestions for achieving consensus on construction of Kalabagh Dam between the Provinces of Pakistan.

1. PAKISTAN - A WATER DEFICIENT COUNTRY

The Country is facing serious water shortages for farming to meet the food and energy requirements of the burgeoning population. The population of 32.4 million in 1948 increased to 154.6 million in 2005 and is estimated to increase to 221 million by 2025. Even a conservative estimate indicates that it may increase to 173 million by this time.

Pakistan is mostly an arid region. Precipitation is so scanty that crops cannot grow without irrigation. Surface water is used for irrigation through an extensive irrigation system in the Indus plain, where rivers are the primary source of water. The river flows however, in Pakistan are in two distinct seasons i.e., Kharif (Summer) and Rabi (Winter). The river flows data show that in Kharif season about 84% of the flows occur while the Rabi season has only 16% of the annual flows. The crop water requirements are however 60% in the Kharif Season and 40% in the Rabi season. Thus there is a great disparity between the water availability and their requirement in the Rabi season. In view of the shortage of water in the Rabi season, it is not possible to have the required quantity of water available at the required time. For getting optimum production from the crops it is essential that the water is made available when it is needed.

Pakistan is highly deficient, as far as water storages are concerned. Out of total flows of the Indus and tributaries of 145 MAF, the present live storage capacity in Pakistan is 11.77 MAF which is only 8 % of the total annual flows. The storage capacity in Aswan Dam (Egypt) is 132 MAF which is 350% of the annual flow of the Nile river. In Pakistan about 1040 MAF of water has gone to the Sea unutilized for the last 34 years. Our inability to construct storages after completion of Tarbela reservoir in 1976, is imposing heavy penalties and constraining economic growth.

These simple facts demonstrate how short-sighted Pakistan has been in the utilization of its water resources. If the situation is not remedied forthwith the food shortages and economic disasters will be difficult to avoid. The country does not have much time available and Government must convince itself and the federating units as to what is essential, in the coming years, for the economic safety of Pakistan.

The recent ECNEC's approval of the multi-billion-dollar Diamer Basha Dam (DB Dam) straddling the Indus on the borders of the Northern Areas and the NWFP has cleared the way for starting work on the first mega storage project in 34 years since Tarbela dam. With construction to begin in 2010-11 and due to be completed in 2020-21, Diamer Basha is expected to produce some 4500 MW of electricity. So robust a generation capacity will certainly go some way in tackling the country's growing energy crunch. At the same time this Dam would also help tackle some of the irrigation requirements of the four Provinces. However the building of this Dam presents a number of engineering, environmental and cultural challenges. The project will flood 59 miles of the Karakoram Highway (KKH) and would wash away prehistoric rock carvings in the Northern Areas in addition to disturbing the ecological balance of the northern Area. For transportation of construction material, heavy machinery and equipment to the dam site, 203 miles of KKH (Havellian to dam site) will be rehabilitated/up-graded prior to start of Project construction. Construction & maintenance of high voltage transmission lines from the Dam site to the load centre will involve serious risks & high costs.

There are cries against water shortage all over the canal commands. Further more public is feeling crushed by very high energy tariff of IPPs thermal plants. Expensive electricity is a serious constraint to agriculture and industrial expansion.

Consequent to increasing water demand and decreasing supply, serious disputes would arise between the provinces on the sharing of a scare resource particularly in the critical sowing period of Kharif and Rabi. It is already happening between Sindh and Punjab with increasing frequency. There would be water conflicts within the provinces as well as quarrels would arise among the upper and lower share holders on the same canal. Water scarcity could thus be harmful not only to agriculture of the provinces but inter provincial harmony as well. This could lead to wide spread socio-political unrest in the country. In order to mitigate adverse impact of emerging water shortage and resulting food and energy crisis, there is urgent need for construction of one more dam immediately.

The large storage project which can be constructed in a period of 6 years is the Kalabagh Dam (KB Dam). KB Dam had been planned to come on line by early 1990's as the project had been under planning since 1954. The project planning studies, detailed designs and tender documents were carried out by a joint venture of five engineering firms, with funds provided by the UNDP. The World Bank supervised the studies in the capacity of Executing Agency. KB Dam is the best option, the quickest vehicle for harnessing water and hydel resources and a project whose construction could be undertaken immediately, along with DB Dam, because all its basic documents stood finalized. Only international tendering is needed to be done and once that hurdle is crossed, construction could commence immediately. Its construction needs to be started without any further delay. The total cost of the Project was worked out as 6.12 billion US $ in the year 2005.

In the face of growing water shortage (water shortages both in Sindh and Punjab are very alarming), viable alternative for increasing supplies is the construction of Kalabagh Multipurpose Project. Any delay in the construction of

ready-to-build KB Dam, could have far reaching ramifications not only economically but socio politically as well. Water scarcity and lack of cheap hydro energy would constrain agriculture and industrial production. There would be much larger wheat imports. Foreign exchange earning potential exportable crops such as cotton and rice and industrial manufacture would be largely benefited. With meagre foreign exchange resources and loss of potential of increase in exports, heavy food grain imports would considerably add to our already spiralling external debt and economic nightmares.

2. SUPERIORITY OF KALABAGH OVER DIAMER BASHA DAM

Kalabagh Dam (KB Dam) Project is a far superior Project than Diamer Basha Dam (DB Dam). Its superior features have been briefly illustrated in the following paragraphs:-

i) Very Suitable Location

The Dam site is located on the Indus River in Mianwali District which is easily accessible from all sides, close to the load centre as well as distribution network of power transmission. It is 121 miles downstream of Tarbela Dam. On the other hand DB Dam is located 197 miles upstream of Tarbela involving long and difficult access routes, far removed from the load centre and difficult transmission corridors through rugged mountains for conveyance of generated power to the load centres.

ii) High River Flows

The mean annual river flow at Kalabagh is 90.00 MAF due to many additional tributaries and nullahs that join the Indus River between DB Dam and KB Dam (like Kabul, Swat, and Kuram rivers on the right and Siren, Haro and Soan rivers on the left). On the other hand the mean annual river flow at DB Dam is only 50.54 MAF i.e 57% of that at KB Dam. Similarly the basic design flood to be handled at Kalabagh is of the order of 2,200,000 cusecs against only 713,360 cusecs at DB Dam i.e. hardly 32% of that at KB Dam.

iii) Very Small Dam

At Kalabagh the height of Dam will be only 260 feet above river bed while DB Dam will be 893 ft. In addition the KB Dam will be an earth-fill Dam while DB Dam will be a Roller Compacted Concrete (RCC) Dam. Inspite of its height equal to about 3.4 times that of KB Dam the live storage potential at DB Dam will be 6.4 MAF against 6.1 MAF at KB Dam, an insignificant advantage from a much higher Dam.

iv) Longer Life Due to Flushing through Low Level Spillway

At KB Dam the orifice spillway has its crest level at 785 ft (above Mean Sea Level) with full reservoir pond level at 915 ft. This low setting of the spillway crest has the potential of flushing of sediment from the reservoir. At DB Dam the spillway crest is at elevation 3758 ft. with full pond level at 3806 ft. (AMSL) and by virtue of its high setting, no significant advantage will be available for flushing of sediment.

v) Very Easy Access to the Site

Due to its location, the access to KB Dam will be very easy which will lead to many economic advantages in transportation of construction materials and machinery, construction of access roads and transmission lines, carriage of machinery for the powerhouses as well as subsequent maintenance and repair works of the project. For DB Dam 203 miles of access road will have to be upgraded and improved and 59 miles of KKH will have to be raised and rebuilt through mountainous ranges along the Indus River.

vi) Very Economical Transmission Lines

The power generated at KB Dam can be connected with the national grid running a short distance away from the Dam site, while the power generated at DB Dam will have to be transmitted over a long distance of 197 miles upto Tarbela Dam. The transmission lines will be erected through difficult mountainous corridors at a huge cost. The maintenance cost of such transmission lines will also be very heavy.

vii) Shallower Bed Rock at Dam Site

The bed rock in the river bed at Kalabagh is 83 ft. below the river bed, while at DB dam site it is 171 ft. deep. The foundation of the dam has to be taken to the bed rock & therefore deeper bed rock means more cost.

The following figures show the site conditions.

Dam	River Bed Level at Dam Site	Bed Rock Level at Dam Site	Depth to Bed Rock (2-3)
1	2	3	4
Kalabagh Dam	± 683 ft.	± 600 ft.	83 ft.
Diamer Basha Dam	± 950 m.	± 898 m.	52 meters = 171 ft.

viii) Lighter Intensity of Earthquake

The earthquake intensity at Kalabagh is comparatively lighter at Kalabagh than at the DB Dam. The following figures show the values adopted in the design of the two dams.

Dam	Operating Base Earthquake (OBE)	Max. Design Earthquake (MDE)	Max. Credible Earthquake (MCE)
Kalabagh Dam	0.15 g	0.32 g	0.4 g
Diamer Basha Dam	0.22 g	0.37 g	0.46 g

ix) Shorter Construction Period

KB Dam is ready for construction and can be completed in a period of six years. The implementation period of DB Dam extends over a period of 10 years and due to the problems of difficult access and RCC technology for dam construction as well as transmission lines there are more chances of further delays in the accrual of benefits from this project.

x) Increased Power Generation at Tarbela

Since KB Dam is located downstream of Tarbela, the releases for irrigation supplies can be regulated at the KB Dam. Taking advantage of this facility Tarbela Dam can be used to generate more power without any restriction due to the fixed releases for irrigation. It is estimated that the extra power that can be generated at Tarbela Dam will be of the order of 336 GWh.

xi) Low Project Cost

Cost wise KB Dam is substantially cheaper than DB Dam. Estimated costs of both the projects are given below:-

KB Dam cost estimated in Sept., 2005 = US $ 6.124 billion.

DB Dam cost estimated in June, 2009 = US $ 11.178 billion.

The cost of DB Dam project is 182.5% of KB Dam cost. The cost of BD Dam given above does not include the costs of two double circuit 765 KV transmission lines to load centres and one double circuit 132 KV transmission line to Northern (Gilgit-Baltistan) areas and upgradation of 203 miles long KKH.

3. MEETING POWER REQUIREMENTS OF THE COUNTRY

DB Dam and KB Dam are not mutually exclusive. Infact, both are indispensable for meeting the growing water & power requirements of the Country. It must be emphasized that there is no alternative to Kalabagh for providing the hydropower (3600 MW) and irrigation water (6.1 MAF) in the coming years as no comparable project has reached the construction stage which Kalabagh reached more than 20 years ago.

It is time the government should start taking the long awaited steps to accomplish the vital tasks in respect of KB Dam Topping the list of these vital tasks is the delicate and politically challenging one of forging national consensus (for which, regrettably, no step appears to have been taken so far). Even if accomplished, consensus would need to be followed up by efforts to raise funds for the investment of around 6 billion dollars. The fund raising task would need the blessings and support of the international donors, in particular, the World Bank and the Asian Development Bank. Success in these tasks would, in large measure, depend upon the findings of the studies, which would need to be conducted by independent international experts to meet the concerns regarding the social and environmental impacts of the project.

For the Kalabagh project to be finally completed with all of its planned power units (3600 MW) commissioned by 2018, the construction would need to commence latest by year 2012. To meet this deadline the Government needs to initiate immediately the activities for undertaking the above mentioned vital tasks. This programme would demand that the required social and environmental impact studies should be completed latest by end of 2011, and as such, necessary administrative and financial arrangements for having the studies conducted by independent international experts would need to be made as soon as possible to meet this deadline.

In the din of politicking that has, unfortunately, surrounded the Kalabagh project, its important potential, (hydropower generation) has been overlooked. The present day shortage of power in Pakistan is of the order of 4000-5000 MW which can be substantially covered by 3600 MW generation at the KB Dam. Once on line, its power station would go a long way in meeting the needs of expanding industries and agriculture and bringing down the country's over all cost of power production. That would make it possible for the government to effect a sizeable reduction in tariff. At present, the consumer, whether domestic, agricultural or industrial, is paying through his nose. With the high cost of electricity our agricultural produce is at a great disadvantage in the international market, our industries would find it hard to compete once the WTO regime comes into force. The cost needs to come down a great deal to pave the way for economic development.

There is a common slogan that KB Dam will be built after developing consensus of all Provinces, but nothing seems to be happening to get this consensus. On the contrary, the present governmental approach is to shelve the project. The delay, in addressing and resolving the objection against KB Dam at the political forum, like Assemblies, is not understandable. The question of water and power is so vital to our survival that all out efforts should be made to iron out differences, mainly rooted in political considerations, among the four Provinces. As a nation we need to be educated by experts on the subject of storages. Instead of making rash political statements, we should have frank and open debates on TV and public seminars where the pros and cons should be discussed thread and thrum so that a national consensus can be developed and work be started, to built desperately needed KB Dam without further delay.

4. DISPUTE RESOLUTION FOR KALABAGH DAM PROJECT

Availability of a suitable dam site together with river flow to fill its reservoir is a gift of Nature to a lucky Nation. We are guilty of denying this gift.

KB Dam is a matter of life & death for the future prosperity of Pakistan. It is more so for the Sindh province which is deficient in rainfall and sweet ground water. All national & international experts have confirmed its technical & financial viability. We have already lost more than 20 years in the pursuit of its implementation. It is vitally important that no more time should be lost in keeping the matter dormant. In order to move forward, it is vitally essential to set up two Commissions for the purposes explained below:-

i) Dispute Resolution Commission

The "Dispute Resolution Commission" should consist of politicians, engineers & public figures of repute who should keep the matter alive & constantly stirred. Some foreign experts on dispute resolution should also be involved. This commission should actively pursue the matter till its final conclusion particularly the following issues:-

a) It should be forcefully propagated with facts & figures among the people in Sindh that Sindh will be the maximum gainer if the KB Dam is built and will be the worst sufferer if it is not.

b) The real causes of opposition to the building of the KB Dam should be sorted out and their remedial measures adopted to start implementation of the Project.

Many complicated issues in the World have been successfully resolved by conflict resolutions like the Camp David Accord etc. There is no reason that KB Dam issue should continue unresolved, particularly when the facts are not on the side of its opponents. As a matter of fact the major issues have already been settled. The shares of Provinces have already been agreed through the Water Accord of 1991. Releases downstream of Kotri Barrage have also been determined through the "Study Report on Water Escapages Downstream Kotri Barrage" by an American Company "Montgomery Watson Harza (MWH) in association with Pakistani Companies (NESPAK & ACE).

ii) Judicial Commission

The Judicial Commission should consist of retired Judges of the Supreme Court of Pakistan & the High Courts of all the Provinces. This Commission should hear all the concerned parties and sort out real issues from the non-issues. Under the present scenario, public at large is confused with the host of non-issues. Once this fog is removed, the road map for construction of KB Dam will be clear and the Nation will be set on the path of progress which is so vital for the existence of Pakistan.

5. DIAMER-BASHA AND KALABAGH DAM PROJECTS

Designed Technical Parameters and Salient Features

Sr. No.	DESCRIPTION	KALABAGH DAM	DIAMER-BASHA DAM
1	2	3	4
1.	**LOCATION**	121 miles downstream of Tarbela	197 miles Upstream of Tarbela
	• Catchment Area	110,500 sq. miles	59,150 sq. miles
	• Mean Annual		
	- River Flow	90.05 MAF Average (1922-2004)	50.54 MAF Average (1962-2003)

Sr. No.	DESCRIPTION	KALABAGH DAM	DIAMER-BASHA DAM
1	2	3	4
	- Total Estimated Sediment Load	470 Million Tons (Sluicing will extend the life to perpetuity)	196 Million tons
	• Flood assessment - Basic Design Flood	2,200,000 cusecs	713,360 cusecs
2.	**MAIN DAM**		
	• Maximum Height above rock foundation	343 Ft. (260 Ft. above riverbed)	893 Ft.
	• Type	Embankment type.	Roller Compacted Concrete (RCC) Gravity Dam
3.	**DIVERSION SYSTEM**		
	• Diversion Tunnels		2 No. (Right side)
	• Diversion Channel	Open Diversion Channel on left side.	1 No. (Right side)
	• Cofferdams	Upstream and downstream	Upstream and Downstream
4.	**SPILLWAY**		
	I. Orifice		
	• Crest Level (AMSL)	785 Ft.	3,758 Ft.
	• No. of Gates	10	14
	• Capacity	890,000 cusecs	640,200 cusecs
	II. Overflow	860 Ft.	
	• Sil Elevation	700,000 cusecs 860 Ft.	
	• No. of Gates	10	
	• Capacity	700,000 cusecs	
5.	**RESERVOIR**		
	• Full Supply Level (FSL)	915 Ft.	3,806 Ft.
	• Minimum Operating Level (MOL)	825 Ft.	3,478 Ft.
	• Live Storage	6.1 MAF	6.4 MAF
	• Length of Reservoir at FSL	92 mile	58.43 mile

Sr. No.	DESCRIPTION	KALABAGH DAM	DIAMER-BASHA DAM
1	2	3	4
	• Length of Reservoir at MOL	75 mile	42.9 mile
	• Reservoir Area at FSL	164 sq. mile	44.5 sq. mile
6.	**OUTLETS IN DAM BODY**		
	• Low level	4 Nos.	2
	• Flushing		5
7.	**FLUSHING TUNNELS**		
	• Right Bank	Flushing will be done through low level orifice spillway	1 (through conversion of one diversion tunnel)
	• Left Bank		1 (underneath the power intake)
8.	**POWERHOUSE(S)**		
	• Location and Type	Indoor Left bank, close to the downstream toe of the dam.	Underground, one each on right and left side
	• Total Installed Capacity	3,600 MW (12x300 MW)	4500 MW (2 x 2250 MW)
	• No. of Units	12	12 (6 x 375 MW in each powerhouse)
9.	**AVERAGE ANNUAL GENERATION**		
	• At Dam Power House	11,413 Million Kwh	18,097 Million Kwh
	• Additional at Tarbela	336 Million Kwh	1,111 Million Kwh
10.	**TURBINES**		
	• Type	Francis	Francis (Vertical Shafts)
	• Number	12 Nos.	12 Nos. (6 units in each of the powerhouses)
	• Design rated head	169.95 Ft.	559.38 Ft.
11.	**PROJECT COST**		
	• Estimated Cost	US $ 6.124 Billion (September 2005 prices)	US $ 11.178 Billion (June 2009 prices). Does not include the

Sr. No.	DESCRIPTION	KALABAGH DAM	DIAMER-BASHA DAM
1	2	3	4
			costs of two, double circuit 765 KV transmission lines to load centers and one 132 KV double circuit transmission line to Northern (Gilgit-Baltistan) Areas and up-gradation of 203 Miles KKH.
12.	**AFFECTED LAND**		
	• Agricultural Land	35,000 Acres	2,811 Acres
	• Barren Land and others	105,406 Acres	34,608 Acres
	• Total Others	140,406 Acres	37,419 Acres
13.	**AFFECTED POPULATION**		
	• (Nos.)	120,000	28,650
14.	**RESETTLEMENT**		
	• Proposed new settlements around reservoir periphery	27 Model Villages	9 Model Villages
15.	**INFRASTRUCTURE**	• A metalled road and a railway line run along the left bank of river about 7 miles from the site. An access road to the site and an air-strip have been constructed. A railway cum road bridge across Indus exists at Kalabagh about 13 miles downstream of the site.	• For transportation of construction materials, heavy machinery and equipment, to the dam site, 203 miles of KKH (Havellian to dam site) will be rehabilitated/ up-graded prior to start of Project construction.
		• The project has the great advantage of being near the major load centres and main transmission corridors.	• The reservoir will submerge about 59 miles of the existing KKH. During construction 85.52

Sr. No.	DESCRIPTION	KALABAGH DAM	DIAMER-BASHA DAM
1	2	3	4
			miles of KKH (Shatial to Raikot Bridge) shall be built at higher level to replace the road submerged in the reservoir. • The power dispersal from Basha will be through two 765 KV double circuit transmission lines and one 132 KV double circuit line to Gilgit via Chilas for supply of Power to Northern (Gilgit-Baltistan) Areas.
16.	**PROJECT BENEFITS**		
	• Availability of annual surface water storage for supplementing irrigation supplies during low flow periods.	• 6.1 MAF • Installed capacity of 3600 MW • Reduction of dependence on thermal power, thus saving foreign exchange.	• 6.4 MAF. • Installed capacity of 4500 MW • Reduction of dependence on thermal power, thus saving foreign exchange.
	• Harnessing of renewable source of affordable energy.	• Employment opportunity, particularly to the locals, during the construction and operation periods.	• Employment opportunity, particularly to the locals, during the construction and operation periods

Sr. No.	DESCRIPTION	KALABAGH DAM	DIAMER-BASHA DAM
1	2	3	4
		• Flood control. • Creation of massive infrastructure leading to overall socio economic uplift of the area and standard of living of the people. • Fish breeding in lake. • Industrialization.	• Flood control. • Creation of massive infrastructure leading to overall socio economic uplift of the area and standard of living of the people. • Fish breeding in lake. • Industrialization.