

**GHAZI BAROTHA PROJECT ON INDUS RIVER IN PAKISTAN**Engr. Dr. Illahi. B. Shaikh<sup>1</sup>**ABSTRACT**

In order to use the available water from the Indus River and use the natural head of 76 meters available in the area, the Government of Pakistan has constructed the Ghazi Barotha Project on the Indus River through the Water and Power Development Authority (WAPDA), which also produces 1450 MW of hydropower. The project is running successfully with minimal environmental disruptions and has properly addressed resettlement issues in consultation with donors. This paper describes the Ghazi Barotha Project in Pakistan.

**BACKGROUND INFORMATION**

Only about 3 % of the world's total water resource is fresh (non-saline) water, of which roughly one-third is inaccessible. The rest is unevenly distributed. In many areas, the existing water resources are increasingly contaminated with wastes and pollution from industrial, agricultural and domestic sources. Over the years, rising population, growing industrialization, and expanding agriculture have led to a rising demand for water. South Asia is one of the most densely populated regions of the world. It houses roughly one-fifth of the world's population, and this share is likely to increase to one-fourth of the total world population by the year 2025. The economies of the countries in the region are heavily dependent on agriculture.

In the case of Pakistan, water has played a very significant role in the nation's economic development and will continue to be a driving force in its future development. Agriculture is the largest sector of the economy, with primary commodities accounting for 25% of Pakistan's GDP and 47% of total employment, and contributes more than 60% of foreign exchange earnings. The principal crops include wheat, rice, cotton, sugarcane, oilseeds, fruits, vegetables, pulses. The overall yield per hectare of most crops is far below their demonstrated potential. Irrigated agriculture yields can be increased through use of improved technology and better management of the highly complex agricultural management system.

Pakistan, with a geographical area of 796,101 square kilometers, contains the large Indus River which, alongwith its 5 tributaries (Chenab, Jhelum, Ravi, Kabul and Sutlej), forms one of the mightiest river system of the world. The irrigation system currently serves an area of 17 million hectares (42 million acres). The Indus River and its western tributaries bring an average of about 175 BCM (142 MAF) of water annually and the average annual canal withdrawal is 128 BCM (104 MAF).

The Indus River System is comprised of :

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- 19 large river headworks
- 45 independent irrigation canal systems measuring 64,000 kilometers.
- Approx. 1.6 million kilometers of water courses
- 94 large dams with heights of 15 meters and above, including 3 super storage reservoirs.
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Figures 1 and 2 show a map and schematic diagram of the Indus River Irrigation System.

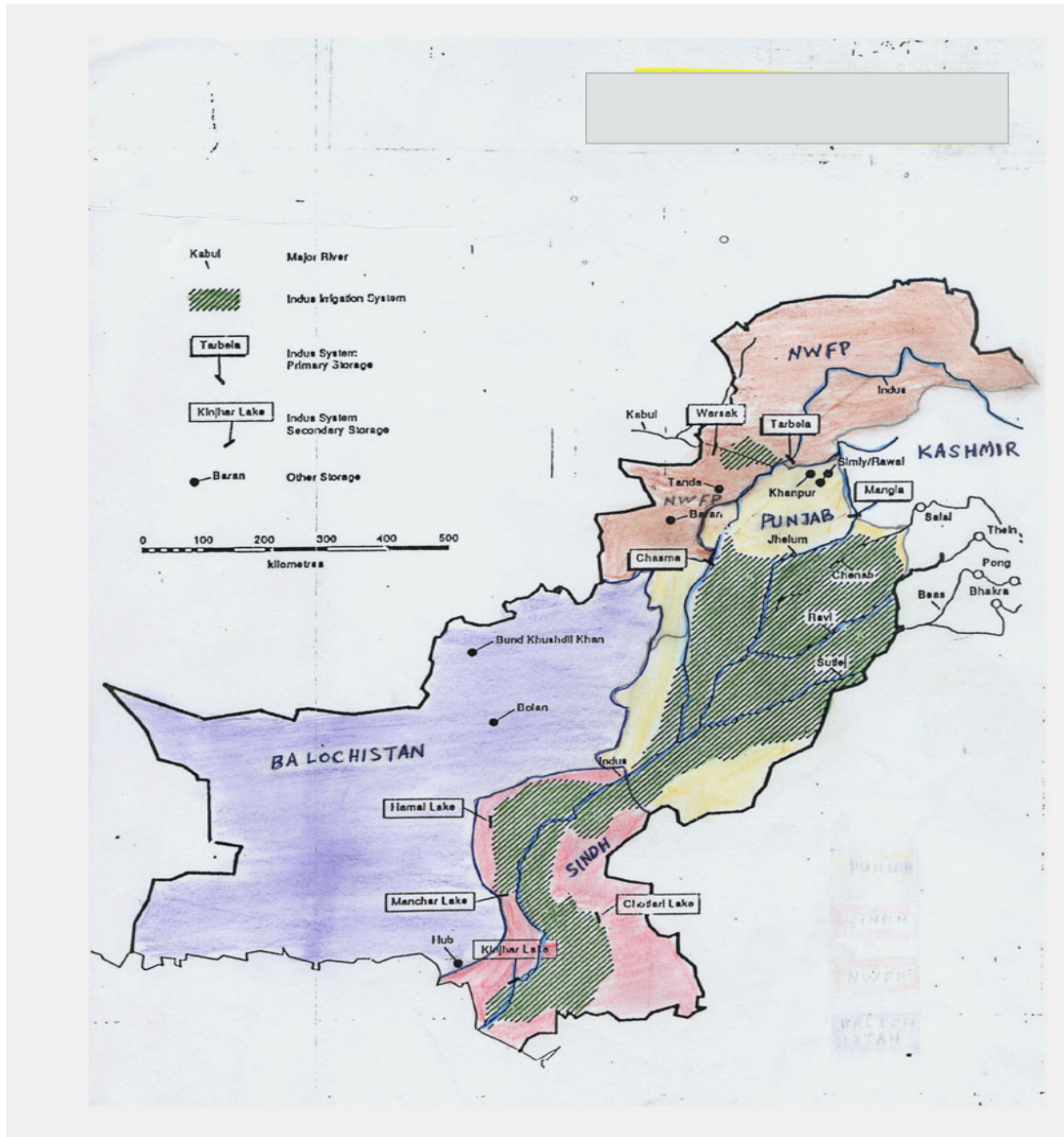


Figure 1. Indus irrigation system and surface storage map

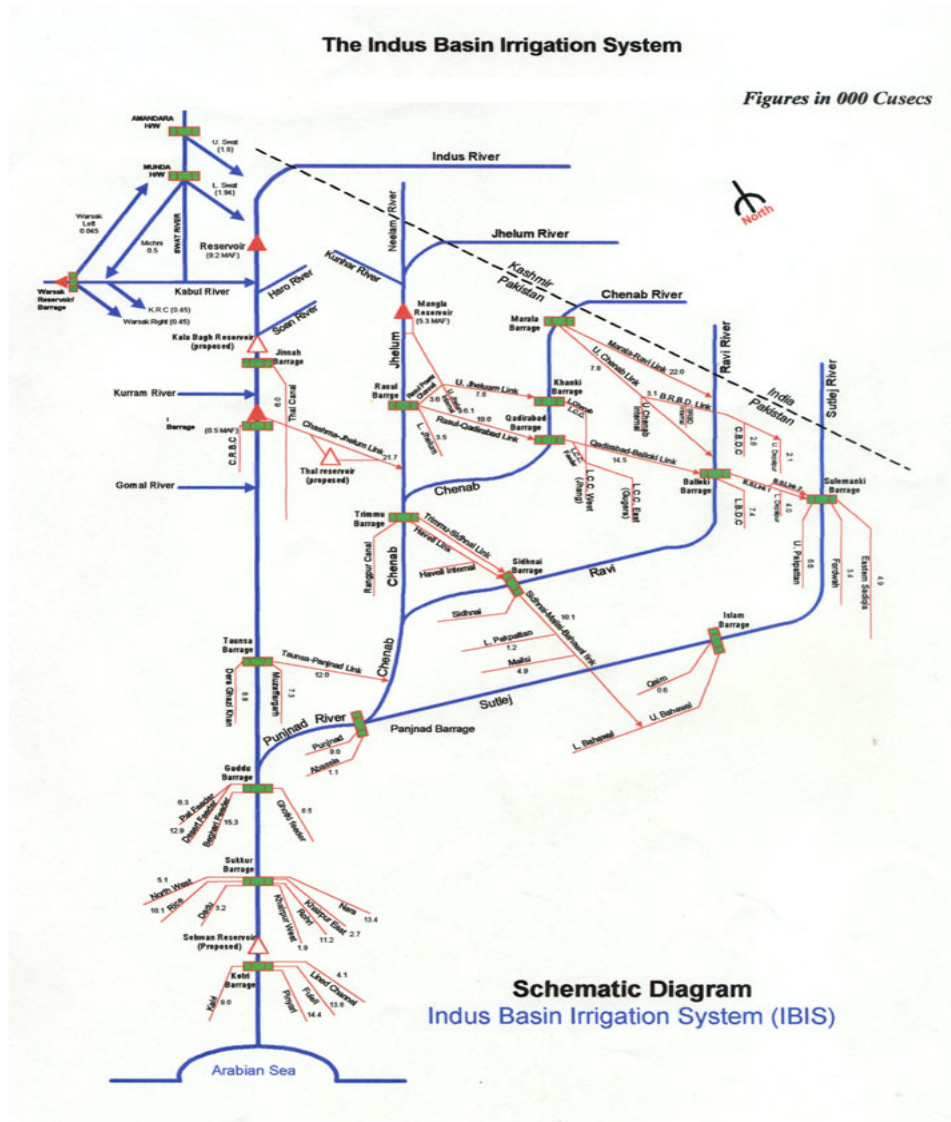


Figure 2. Indus Basin irrigation system diagram

Pakistan is a country of over 150 million people, which is expected to grow to about 221 million by the year 2025. The most pressing need over the next quarter century in Pakistan will be the management of the rapidly increasing population and provision of basic amenities. The increasing population will have a major impact on food and fiber requirements.

As the population continues to grow, Pakistan is now essentially at the limit of its water resources and is becoming a water scarce country. There is a strong and growing need to manage this precious resource more carefully and efficiently to ensure water for all on a sustainable basis. In order to effectively use water to meet the future demands for food and rural development, there is need to evolve strategies for development, management and conservation of water resources. A good proportion of the water which will supply the additional needs of the

future must come from conservation and continued investment in the Irrigation, Drainage and Hydropower Sector. The food needs of the future can only be met through combined efforts in water conservation, additional storages and most importantly through increases in crop yields.

Additionally, Pakistan's large river systems have discharges during the summer season that can vary from 3,000 to 34,000 Cusecs (100, 000 to 1,200,000 Cumecs) and which cause tremendous losses to human lives, crops and property. Due to the limited storage capacity at the Tarbela and Mangla Dams (on the Indus and Jhelum rivers, respectively) and with virtually no control on the Chenab, Ravi and Sutlej rivers, devastating problems occur between July and October in the event of excessive rainfall in the catchments.

### GHAZI BAROTHA

The town of Ghazi in Tehsil Haripur is just 7 kilometers downstream from Tarbela Dam. The Project Layout plan and a photo of the barrage are shown in Figures 3 and 4. Between Ghazi and Barotha, the Indus River drops 76 meters. WAPDA decided to build a structure to divert water into a 51,900 meter power channel that follows a relatively flat gradient as compared to the river, providing a drop of 69 meters. After producing electricity, the water is returned back to the Indus River. WAPDA carried out initial feasibility studies in 1987. In 1991, feasibility studies were completed by Pakistan Hydro Consultants, a joint venture of NESPAK (the largest engineering national consulting firm) and ACE from Pakistan, Ewbank and Binnies from the United Kingdom, and Harza from the United States. Pakistan Hydro Consultants also acted as WAPDA's consultant for design and construction supervision during the development of Ghazi Barotha.

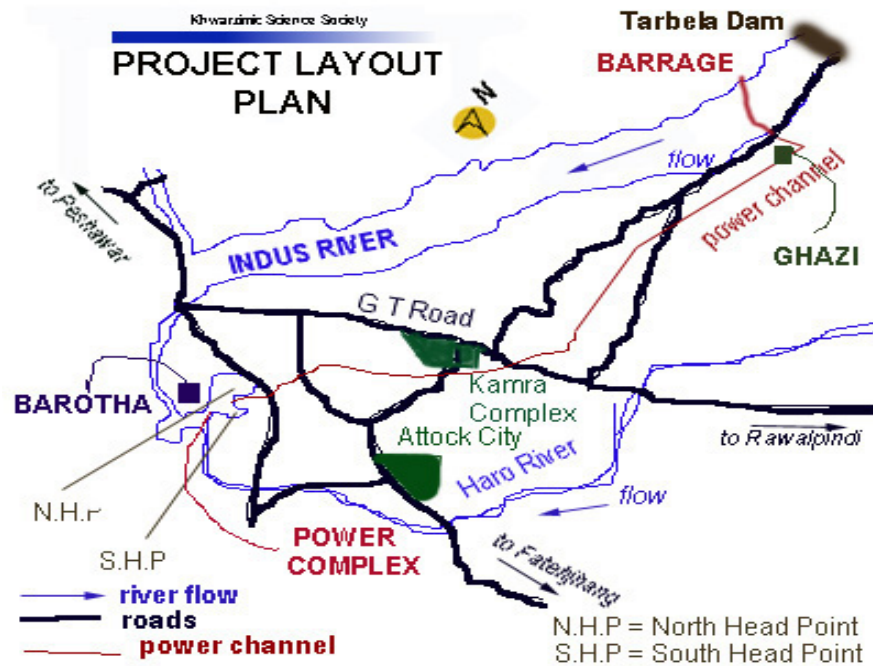


Figure 3. Project Layout



Figure 4. Ghazi Barotha Barrage on the Indus River in Pakistan

Quantities of indigenous oil, gas or fossil fuels in Pakistan are limited, so the focus of energy proposals are currently on hydropower to minimize the fuel import burden. The Water and Power Development Authority (WAPDA) designed the 1,450 MW Ghazi Barotha Project on the Indus River to fulfill this vital need. Unlike WAPDA's 1,000 MW Mangla Dam on the Jhelum River and 3,478 MW Tarbela Dam on the Indus, Ghazi Barotha is not an impoundment dam but a run-of-the-river project. Ghazi Barotha provides examples of several "good practices" in hydro development. In spite of various implementation difficulties related to site conditions and funding shortfalls, WAPDA completed the project with only a 7.96 % increase in the original estimated cost. The completion cost of the project was Rs 96,957 million and the project was fully completed on June 30, 2006 with EIRR as 22.19%. Of note is the unique design of the water channels and powerhouse, which allowed WAPDA to minimize environmental and social effects. Today, Ghazi Barotha contributes 6,600 gigawatt-hours (GWh) of environmentally-friendly electricity to more than 2 million homes each year.

#### UNIT COST ANALYSIS

|      |  |   |                      |
|------|--|---|----------------------|
| i)   | Installed Energy                             | = | 1450 MW              |
| ii)  | Average units generated                      | = | 6586 GWh             |
| iii) | System losses and consumption in auxiliaries | = | 1589.64 GWh          |
| iv)  | Net units available for sale                 | = | 5005.36 GWh          |
| v)   | Annual recurring charges                     | = | Rs 8500 M            |
| vi)  | Cost per unit generated = (8500/6586)        | = | Rs 1.29 = 0.021 US\$ |
| vii) | Cost per unit sold = (8500/5005.36)          | = | Rs 1.70 = 0.028 US\$ |

### CONCLUSION

As the population grows there is strong and growing need for Pakistan to manage its precious water and other energy resources more carefully and efficiently and sustain continued investment in Irrigation, Drainage and Hydropower Sectors to meet the future demands of food and energy.

### REFERENCES

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