WATER RESOURCES DEVELOPMENT IN PAKISTAN A REVISIT OF PAST STUDIES

By

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Abstract

Three-fourths of the Earth's surface is covered with water. Only 1% of the World's water is usable, about 97% is salty sea water and 2% is frozen in glaciers and ice caps. All life on earth depends on water. Population is increasing and hence water availability per person is reducing. Civilizations have historically flourished around rivers and major waterways and for centuries these waterways have been a source of their livelihood. In modern times a remarkable irrigation network was developed by the British in the Indus river basin and at the time of partition the dividing line of the sub-continent disregarded not only the topography but also the irrigation boundaries of the then existing canal supply system. This created great challenges for the water resources development work in Pakistan.

This paper discusses the importance of water and its role in the economic development of a country through increase in agricultural and industrial development. It traces the path as to how in Pakistan over the last 67 years various studies were carried out for the planning and development of water resources in the country. It discusses the steps that need to be taken today so that ample water is made available for our future generations for their survival.

1. INTRODUCTION

All life on Earth depends on water, whether it is a plant in a desert, an animal in a wilderness, an insect in a rock crevice or a fish in a lake. Life will cease to exist on this planet if there is no water. History shows that humans have fought for control over water sources in the past and its scarcity in future could lead to conflicts and wars among nations.

Man has always wanted to live with adequate food and comforts. Food is essential for his survival and to grow food he needs water. Similarly, to live in comfort he needs energy. Energy can be generated by utilization of natural resources for example water and its potential head, wind velocity, solar radiation, nuclear fission or burning of fossil fuels like oil, gas and coal. Out of all these the hydropower is a cheaper source of energy for Pakistan. Pakistan has yet to develop and fully utilize its water resources for growing food and generation of electricity.

Quality of life of the people can be improved by economic development of indigenous resources. Mexico and USA have demonstrated in 1960's that irrigated agriculture can bring a green revolution in the country and boost its economy. In Pakistan agriculture is the main stay of economy. The irrigation network in the Indus Basin is the largest

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contiguous network in the world. Its proper maintenance and efficient operation is of prime importance for sustainability.

2. HISTORY OF IRRIGATED AGRICULTURE

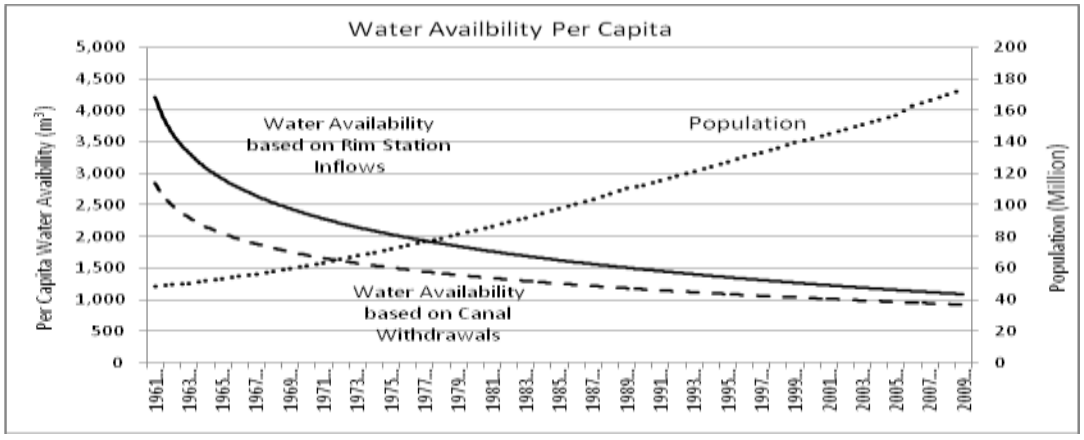
The early civilizations of Mohenjo-daro and Harappa have proven the potential of this resource. Prosperity was gained through their agricultural produce. The British government in India occupied Sindh in 1843 and Punjab in 1847 and immediately setout to harness the water resources of these areas which is now Pakistan. In 1859, the first man-made canal for irrigation supplies was constructed from Ravi river by the Irrigation Department of Punjab. Prior to this all cultivation was dependent on Persian wells, inundation canals, rainfall (barani) or river bank flooding like in Katcho areas along the banks of Indus river in Sindh.

During the British period Punjab was mostly growing wheat and feeding all neighboring provinces. Good quality cotton was cultivated in Sindh which was largely exported to England for manufacturing cloth in the factories of Manchester. For sustainability of their textile industry the British Government had to give preference to the water development projects in Sindh.

The Sukkur Barrage project was approved in 1923 and commissioned 9 years later in 1932. The canals taken out of Sukkur barrage brought a boom to the agriculture in its command areas. This was followed by the construction of several other barrages in Punjab. Over the next 40 years a large and complex irrigation network was built bringing prosperity in India as well as England. The sustainability and efficiency of irrigation network needs continued efforts for maintenance of infrastructure and its expansion which is necessary to meet the demands of growing population.

3. WATER AVAILABILITY

Fresh water is a finite commodity and its continued availability is facing great challenges. On the other hand human demand for water continues to grow. The countries that face shortages are also increasing in area and number. Pakistan is one such country where overall water availability per capita has gone down from 5,260 m^3 in 1951 to the present 1,011 m^3. The irrigation water availability has also reduced from about 2750 m^3 in 1961 to 970 m^3 in 2013. The ever increasing population alongwith emerging water crisis requires a new approach and mindset in managing our water resources.



Pakistan has vast area of cultivable land and the largest contiguous irrigation network but the country is not bestowed with a rainfall pattern that would exactly match the crop water requirements. The abundant summer flows have to be managed and regulated to provide irrigation supplies for Rabi crops (October to March) when the river flows drop down to levels much below the agro demands. Pakistan has to build more storage dams and manage its ground water resource such that, the water quality does not deteriorate.

4. PAST STUDIES

Several high level studies have been carried out in the past for master planning in the water resource development sector. Invariably the recommendations given in these reports could only be partially implemented. Making studies, preparing reports and placing them in book shelves for want of funds has frequently happened. We should consistently pursue the findings and recommendations of study reports that have been accomplished previously giving well considered conclusions and suggestions. It will always be prudent to periodically revisit the studies made in the past and make selections of projects on the basis of some agreed criteria and then start working on those projects with full commitment.

At the time of creation of Pakistan in 1947, the line drawn across land and rivers completely disregarded the topography and hydrologic watersheds. The irrigation canal system existing at that time was ignored generating colossal problems for Pakistan. India got control of Ferozepur and Madhopur headworks whereas the canals taking off from these headworks had their command areas in Pakistan. More than seven (7) million acres of irrigated area in Pakistan was threatened and a solution had to be found. The World Bank intervened and during the 1950's remained busy with tripartite Indus Water Negotiations which eventually led to the signing of Indus Waters Treaty between India and Pakistan in 1960 to meet the new challenges. Since then several technical studies have been carried out for the planning of water resources in Pakistan to meet the new challenges. Some major studies are as follows:

a) Harza's Master Plan 1964:

In early 1960's, WAPDA engaged Harza Engineering Company of Chicago (USA) as General Consultants. One of their main assignments was preparation of Master Plan leading to the "Programme for Water and Power Development Through 1975". This exercise was completed by Harza in 1964 and furnished a good base for further multi-purpose planning studies for water development in the Indus Basin.

b) Sector Planning by World Bank Study Group headed by Dr. Lieftinck

Following the signing of Indus Waters Treaty a Memorandum of Understanding was signed in November 1963 so that most appropriate projects are planned for optimum utilization of the Water Resources of Pakistan. A group of engineers headed by P. Lieftinck carried out this study for the World Bank.

The studies of dams for the storage of water for construction together with studies of dam sites for further developing the water resources of the country were carried out by Chas. T. Main International for the IBRD and report published in 1966.

c) Indus Special Study 1967

During 1964, World Bank offered to Pakistan to organize a multi-purpose study on water and power resources development. The chief purpose of this report, which became known as Indus Special Study, was to develop a programme for optimum exploitation, for agricultural and power purpose of water resources that would be available to Pakistan after implementation of the Indus Waters Treaty of 1960.

Indus Special study was completed over the period 1964-67. A computer based river system simulation model was also prepared to analyze the impact of different water availability patterns on the Plan. The report was titled "Water and Power Resources of West Pakistan. A Study in Sector Planning" and provided a broad outline of proposed developments in 20 years (1965-85) with focus on 10-year action programme from 1965-75.

d) Revised Action Programme (RAP) 1979.

The implementation of Action Programme for period 1965-75 was seriously constrained on account of needed funds and several other factors. It was, therefore, felt necessary to update the Water Sector Action Programme taking into account the prevailing policies on regional balance, poverty alleviation techno-economic priorities and technological advances.

This study was completed over the period 1975-79 and its main objective was to provide a "Revised Action Programme (RAP)" for planning, preparation and implementation of irrigation, drainage, reclamation, surface storage with related hydropower generation and flood protection schemes during 15 year period of 1975-90.

e) Water Sector Investment Planning Study (WSIPS) 1990

After about 10 years of RAP, need was identified for an updated medium term investment plan according to explicit criteria as well as providing mechanism for continuous review of investment projects.

The work regarding "Water Sector Investment Planning Study (WSIPS)" was completed by end of 1990. The main objectives of the study were to:

i) Develop a medium term investment plan for the period 1990-2000.

ii) Develop procedures and criteria for evaluating water sector projects and to prepare rolling plans, and

iii) Recommend specific proposals for upgrading the federal/provincial water sector planning institutions.

f) Report of the Water Sector Task Force for FODP and GOP - 2012

Recognizing that the water resource base of Pakistan is under grave and growing stress from the expanding population and the demands of growing cities and industry, from degradation of water quality and from climate change, the Friends of Democratic

Pakistan (FODP) member countries and the Government of Pakistan instituted a Task force to make a study targeting on the following aims;

i) Double the agricultural outputs.

ii) Triple the output of hydropower.

iii) Reduce the areas adversely affected by major floods and

iv) Provide all urban residents with safe water and treat all industrial and domestic waste water.

The report in Feb. 2013 highlights five major areas in which immediate action is a high priority. Among others, it includes construction of large storage dams on the major rivers and modernization of national policies that govern the use of waters. The report recommends the priority construction of Diamer Basha, Kurram Tangi and Munda Dams as well as Dasu, Kohala, Golen Gol and Bunji hydropower projects. The report also recommends several improvements in the management of water use like rehabilitation of barrages and canals, judicious use of groundwater and adoption of high efficiency irrigation system.

5. DISCUSSION ON PREVIOUS STUDIES

A review of above reports shows that very often the presented plans were only partially implemented. In some cases the projects were not accepted by the relevant provinces (like Sehwan Barrage) and hence dropped or deferred. Comments on some salient projects are given in the following paras:

a) Side – Valley Projects Associated with Tarbela

In recognition of the high rate of depletion of storage capacity at Tarbela, various proposals were considered for side-valley storage reservoirs on the Haro and Soan rivers. A potential capacity of reservoirs on these rivers was indicated to be 30 MAF. Three projects at Gariala, Dhok Pathan and Sanjwal – Akhori were identified and discussed in the Lieftinck report. Of these the Sanjwal-Akhori was deemed less favorable than Gariala because of inordinate amount of earth moving involved and serious foundation problems.

A dam at Dhok Pathan on Soan River was earlier proposed in 1957 by the Planning Department of WAPDA. The dam was proposed to be 210 ft high with a storage that would be fed only through the run-off of Soan river. The report states that, geologically as well as topographically the site is capable of supporting a higher dam. The Lieftinck report envisaged an earth and rockfill structure some 275 feet high which would give a total reservoir capacity of about 7.5MAF. The reservoir was proposed to be fed through diversion of water from Siran pocket of Tarbela reservoir through three parallel canals each about 70 km long with a combined capacity of 76,000 cusecs.

As it happened this recommendation was not considered in good times and taking up such a project now would have an environmental and social impact that would be difficult to handle. Some opportunity is still available to consider a revised scheme of dam on Soan river with its reservoir to be fed from Akhori Dam.

b) Scheduling and Ranking of Projects

The World Bank had conducted this study in 1965 through a study group headed by Pieter Lieftinck. The study recommended following projects for construction in a period 1967-2020;

Recommended Storage Program by Pieter Lieftinck

Project	In-Service Water Year as planned	Initial Live Storage Volume (MAF)	Actual completion Year and Initial Storage (Year – MAF)
Mangla	1968	5.22	1967- 5.34
Chashma	1972	0.51	1971 - 0.72
Tarbela	1975	8.60	1976 - 9.69
Sehwan-Barrage	1982	1.80	Sindh rejects
Raised Mangla	1986	3.55	2012 – 2.9
Chotiari	1990	0.90	2002 – 0.75
Kalabagh (with power)	1992	6.40	Not yet built
Swat (Munda)	2002	2.00	Not yet built
Low Gariala	2011	4.60	Akhori studied
Skardu	After 2020	8.00	Not yet built

The projects at Mangla, Chashma, Tarbela, Chotiari and Raised Mangla have been built. The report shows raised Mangla proposed to be online by 1986. The Mangla Dam Raising Project has been completed 26 years later. Consequently the resettlement cost was far above the original estimates and somewhat more than the actual cost of the Mangla Dam raising works. By adherence to the schedule given in the P. Lieftinck report, the project cost could have been lower and additional benefits of 2.9 MAF water would have been made available much earlier.

c) Irrigation Practices and Need of National Drainage

The Water Sector Investment Planning Study report was prepared by a consortium of local and international consultants in 1990. The following are two examples from the Summary and Conclusions, given in the report that need attention.

The report states that the riverine areas of Sindh, and in particular areas of 'Sailaba' cultivation and the riverine forests, are subject to the likely effects of reduced peak flows and shorter periods of flooding. Additional major storages on Indus system seem likely to worsen this negative impact. Some studies have been made, or are in hand, but a full evaluation of this potential problem is needed.

The present scenario of water situation in the country demands that we should reconsider the continued luxury of flood irrigation. Alternate methods with promise of better yields are available. Water storages are the solution to erratic rainfall and extreme variation in summer and winter flows. The country now needs to adopt water conservation measures, high efficiency irrigation systems as well as to build more of normal as well as carry over storage dams.

The report recommends that disposal of saline effluent poses problem with both regional and long-term potential environmental effects. One major disposal system with final discharge into the sea i.e. LBOD has already been built on left bank of Indus and RBOD on right bank is being built.

There must be additional concern, however, about the increased emphasis in Punjab on drainage of saline groundwater areas by tube wells, since disposal system so far planned or developed cannot be considered as more than temporary. The impact of evaporating ponds is local, while the mixing of saline effluent with canal or river water has a negative impact downstream. This problem is an issue which needs to be studied in a national context.

There is need to build spinal drain to dispose of saline effluent of southern areas of Punjab into sea. If this is not built, a time will come when water quality of Indus from Guddu to Kotri shall deteriorate to unaffordable and unworkable limits. Storage dams can help regulation of flows thus allowing sending down fresh water to dilute the salinity infected river flows downstream and save the collapse of the grandeur of Indus Basin's agriculture.

6. REPORT ON LAND AND WATER DEVELOPMENT IN THE INDUS PLAIN BY WHITE HOUSE, DEPARTMENT OF INTERIOR, USA(1964)

This report was prepared in 1964 and it discusses various problems of the irrigated agriculture of West Pakistan and gives a plan of action to increase productivity and agricultural modernization to achieve maximum benefit from Indus basin. While discussing the summary of the report the author Dr. Roger Revelle writes;

"We are convinced that within a generation West Pakistan's agriculture can undergo a revolution of the kind already occurring in Japan, the United States, and other advanced countries. A rate of increase can be established and maintained which will far outrun the growth of population, and will so improve the economic condition".

The above statement is true even today. It reflects how Pakistan was viewed in the US at that time and how much potential this country is still having. However this potential can only be utilized to its maximum through an integrated approach towards water resources development for enhanced agricultural production.

7. CONCLUDING REMARKS

7.1 Looking back on the planning work done in the past it is found that there have been consistent efforts in master planning for the Development of Water Resources. A well-considered conclusion is that building of Mangla & Tarbela dams alongwith link

canals to bring waters from rivers in the North to the irrigated areas in the South is not enough. Many more associated projects will have to be implemented in the future years. The study group for the World Bank concluded that water availability provided through construction of Indus Basin Treaty Works would continue to decline because of sedimentation in the reservoirs, increasing demands on water due to population growth and aging of the irrigation infrastructure. It was recommended that Pakistan should be building at least one reservoir for storage of about 6 MAF of water every decade.

7.2 The agriculture yields in Pakistan are far lower than the yields achieved by some other countries, as shown in the following table;

Cereal Yield Statistics (Year 2012)

Country	Cereal (kg per hectare)
Egypt	7,693
China	5,837
Indonesia	5,081
Malaysia	4,017
Mexico	3,392
Thailand	3,092
Pakistan	2,834

Source:
http://data.worldbank.org/indicator/AG.YLD.CREL.KG
Note : Cereal yield, measured as kilograms per hectare of harvested land, includes wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains. The Food and Agriculture Organization (FAO) allocates production data to the calendar year in which the bulk of the harvest took place.

The agricultural yield in Pakistan can be and must be improved by employing better irrigation practices. In this regard lessons should be learned from successful countries.

7.3 The past planning reports have also noted that the present crop water requirements especially for wheat, sugarcane and rice are inappropriate and that country-wide studies should be carried out to better define the specific crop water requirements in various districts in the country.

7.4 Recognizing that link canals and intensified irrigation would eventually cause water logging. The irrigation practices using spate and 'Pancho' irrigation as well as increasing use of tubewell waters would cause salinization of soil. Mere construction of two spinal drains i.e. LBOD & RBOD in Sindh would not suffice. A similar spinal drain will have to be constructed through southern Punjab as well, with its disposal into the sea.

Outlet gates should be provided at the tail ends of spinal drains to guard against backflows during high tide of the sea.

7.5 Hydropower is integrated with the water sector projects. Most of the large dams serve the multiple purposes of water storage as well as power generation. The planning and ranking of projects should therefore address both needs of the country. M/s Monenco in their study report of 1989 suggested a ranking of future projects on the basis of Index Capacity assigned to each project which is not necessarily the optimum installed capacity. In the later years it has been realized that the criteria of selection must consider several other factors as well like urgency of need, national demand, provincial preferences, capital cost, economic analysis of the project and remoteness of the site.

RECOMMENDATIONS

7.6 Pakistan should be building at least one reservoir for storage of about 6 MAF of water every decade to maintain its carry over storage capability and regain the storage lost to sedimentation.

7.7 The priority should be given to the construction of Diamer Basha, Kurram Tangi and Munda dams as well as Dasu hydropower project.

7.8 Planning should start to build carry over reservoirs. A revised scheme of dam on Soan river with its reservoir to be fed from Akhori Dam should be considered.

7.9 During canal closure months of December and January the Mangla and Tarbela dams are not allowed to produce power to their capacities. Re-regulating storage projects should be studied to be constructed at Jhelum and Indus rivers downstream of these two dams.

7.10 Criteria of selection for ranking of hydropower projects should be developed which could consider factors like urgency of need, national demand, provincial preferences, capital cost, economic analysis of the project and remoteness of the site. The Planning Commission of Pakistan should prepare standard criteria in consultation with all provincial governments.

7.11 Water conservation measures need to be adopted through the use of high efficiency irrigation systems.

7.12 Using improved agricultural practices increase the rate of agricultural produce which should outrun the growth of population.

7.13 Country-wide studies to define the specific crop water requirements of lands in various districts in the country should be carried out.

7.14 Judicious use of groundwater should be ensured by urgently adopting strict regulation measures.

7.15 A spinal drain to dispose-off saline effluent of southern areas of Punjab into the Arabian Sea should be planned.

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