

# ADDRESSING THE EMERGING WATER SECTOR CHALLENGES IN PAKISTAN: A CASE STUDY OF PUNJAB'S AGING IRRIGATION INFRASTRUCTURE

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## ABSTRACT

The Paper presents a focussed synthesis of the Water Sector issues and identifies strategic interventions for addressing the emerging challenges. It particularly focuses on the need for rehabilitation and modernization of Punjab's aging irrigation infrastructure, which serves as lifeline for the agriculture and agro-based industry of the country. Irrigated lands supply more than 90 percent of the total agricultural production, account for about 25 percent of GDP, and employ around 50 percent of the labour force. They supply most of the country's needed food-grain and also are the source of raw materials for major domestic industries and exports.

Water resources management has acquired new dimensions in Pakistan. A host of multi-faceted factors constrain the performance of irrigation system that ultimately reflect on the sustainability of the agriculture and environment. The major issues facing the irrigation management include Physical Constraints, Financial Inadequacies, Institutional Issues and Environmental Degradation. The Physical Constraints have been caused by the agricultural development beyond the system design capacities, scarcity of irrigation water, lack of storages, and gradual deterioration of the irrigation infrastructure due to the oversteering and aging. In order to address the complex irrigation management issues, comprehensive and holistic strategies need to be conceived and implemented.

The need for rehabilitation and up-gradation of Punjab's aging irrigation infrastructure, which is perhaps the most valuable asset of the province, has become imperative. Indeed, over the last three decades, some of the major structures failed causing stoppage of irrigation water to large areas with huge economic losses. Recent surveys have revealed that a number of important hydraulic structures are in precarious state and the need for their rehabilitation is urgent. Besides rehabilitation, the system also needs overall improvements to allow efficient operation and equitable water delivery in order to cater for the enhanced water demand and to meet the challenges of 21<sup>st</sup> Century. The funding needs for these improvements and the possible financing options have been identified and evaluated.

## THE BACKDROP

Pakistan has the distinction of having the largest contiguous gravity flow irrigation network in the world. It has been estimated that the present value of the Indus Irrigation System is around US \$ 300-500 Billion, while the present value of Punjab's Irrigation Infrastructure is estimated around US \$ 200-300 Billion (NDP Cell, 1997). The System serves as lifeline for sustaining the present

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level of agriculture. In fact agriculture without irrigation is impossible in the arid to semi-arid climate of our country. Irrigated lands supply more than 90 percent of the total agricultural production, account for about 25 percent of GDP, and employ around 50 percent of the labour force. They supply most of the country's needed food-grain and also are the source of raw materials for major domestic industries and exports.

Water resources development and management has assumed new dimensions in Pakistan because of a number of factors, which are reflecting on the irrigated agriculture. In the past, it was possible to keep the agricultural production in pace with population growth, by progressively improving the irrigation water availability. The future prospects are however not very promising and the sustainability of irrigated agriculture appears to be jeopardized due to rapidly escalating water demands, limited water resources and environmental concerns. The deteriorating health of the aging irrigation infrastructure and lack of financial resources to address the emerging rehabilitation and modernization needs of the system is emerging as a major issue that increasingly assuming serious dimensions.

The existing Indus Basin Irrigation System is gigantic and integrated with limited flexibility. The length of main and distributary canals exceed 60,000 kilometers. It serves over 14 million hectares of culturable commanded area through about 100,000 outlets in 43 main canal systems in the four Provinces of Pakistan. The irrigation system had been designed as a gravity flow, run-of-the-river system to support subsistence agriculture at low cropping intensities of 50 to 75 percent. The existing storage capacity of reservoirs, constructed sequel to Indus Water Treaty, is rather small; being less than 10% of mean annual river flows. Further, the time distribution of river flows is highly uneven, as more than 70% of the flows occur during three monsoon months.

## **IRRIGATION MANAGEMENT ISSUES**

A host of factors constrain the performance of irrigation system in Punjab. Various agencies and individuals identify the management issues and constraints according to their perceptions. There is however a growing recognition that the issues of irrigation management are multi-faceted and that the identification of major system constraints is an essential pre-requisite for evolving effective improvement strategies (Haq, 1998).

The irrigation performance needs to be reviewed in the context of system design objectives, operational constraints, institutional systems, and the broader socio-economic framework. Pakistan is a developing country whose socio-economic problems are complex and peculiar in nature. The changes in the physical environments, like those of population growth, increase in demand for land and water, ecological threats, modern technology and new developments in groundwater, all pose new challenges to the management of the irrigation system. Sustainability of an irrigation system depends not only on the economical, technological and ecological factors, but also on the institutional framework within which these factors interact. The specific physical characteristics of a canal system and management practices strongly influence its performance outcome. The major issues facing the irrigation management in the country can be broadly categorized as physical constraints, system overstressing financial inadequacies, and institutional issues (Box-1).

**BOX-1**  
**MAJOR IRRIGATION MANAGEMENT ISSUES**

- System and Supply Constraints**
  - Overall Water Scarcity
  - Agricultural Development beyond System Design
  - Lack of Storages
  - Wide Variations in River Flows
  
- Management Issues**
  - Inadequate Maintenance Funding
  - Sub-optimal Operation and Maintenance
  - Inequitable Distribution
  - Lack of Systematic Monitoring and Evaluation
  - Inadequate Communication and Transport System
  
- Sustainability Concerns**
  - Deteriorating Health of Aging Infrastructure
  - Progressive loss of Storage Capacity due to Sedimentation
  - Depleting Aquifers
  - Environmental Degradation
  - Gap between Revenue and Expenditure
  
- Policy / Institutional Issues**
  - Lack of Holistic Water / Agriculture Policy
  - Institutional Constraints
  - Socio-Economic Issues
  - Stand-still in Water Resources Development

## **SYSTEM CONSTRAINTS**

The Indus Basin Irrigation System was designed with the objective of bringing as much land under canal command as possible. The designed annual cropping intensities were generally kept low, at 60 to 80 percent, and the diversion capacity of canals aimed at spreading the water thinly over a larger area. This policy was considered suitable for the requirement of a small population at that time. The objectives were to support a subsistence level of agriculture, reduce drainage requirements, and bring large blocks of crown wasteland under cultivation.

Over decades of canal system operation, the population has increased manifold, and the sociological, cultural, agricultural and economic practices have changed radically. This has substantially modified the actual cropping patterns and intensities. As a consequence, the design

considerations and capacities, which might have been relevant at the time of the system's construction, are now no longer adequate to meet the present day requirement. With agricultural development over time, the irrigation intensities have increased dramatically. It is estimated that the average annual cropping intensity in the Punjab Province is around 122 percent, against an average designed annual intensity of 63 percent. The cropping intensities in different canal commands vary between 80 percent to around 150 percent. In addition to these, the extensive use of fertilizers, a shift towards higher-delta cash crops and high-yielding crop varieties, and increased water application to maximize the crop yields, have resulted in a tremendous build-up of irrigation water demand not envisaged at the time of system design. Recent studies by the Consultants on the Lower Bari Doab Canal (LBDC) System concluded that the canals supply only 44 percent of the net overall crop water requirements, while groundwater contributes 34 percent of the requirements (PDC, 1999). This still leaves a deficit of 22 percent in a well-developed canal command area, which is endowed with fresh groundwater that the farmers can tap economically. Another study by JICA (1997) also confirms these findings. It reports that the channels of Lower Chenab Canal (LCC) and the Lower Jhelum Canal (LJC) Systems supply only 40-45 percent of the net overall crop water requirements. These overall deficits in canal supplies become much more pronounced during peak demand periods.

The inadequate capacities of the system pose a major constraint in meeting the current irrigation requirements, particularly during very hot summer peak demand periods. The head-reach farmers are tempted to extract more water than their authorized share in order to mature the sown crops, while the tail-reach farmers suffer shortages. Confronted with the canal water shortages, the tail end farmers have been forced to use marginal quality groundwater without proper mixing with the canal water. This is causing environmental degradation due to the build-up of secondary salinity and surface sodicity. As a result, irrigated agriculture and crop yields have received setback in the tail portions of the system. The issue has become increasingly severe over the last two decades due to rapidly growing demand for irrigation water.

## **DETERIORATING HEALTH OF IRRIGATION INFRASTRUCTURE**

The irrigation system has progressively deteriorated because of aging, inadequate maintenance, over-stressing of the channels and structures and a phenomenal increase in the use of canal banks by the human, animal and vehicular traffic. In most cases, the canals have to be run beyond their designed capacities in order to meet the enhanced water demand. This affects the channel regime and also impinges on the operational safety of the hydraulic structures. The increased trespass has been triggered by rapid population growth, farm mechanization, changing social order, and weakening controls. The system deterioration is characterized by weak canal banks, eroded berms, channel cuts and breaches, frequent sedimentation of distributaries and minors and dilapidated condition of canal structures.

Many of the hydraulic structures, which are 50-100 years old have outlived their useful life and are susceptible to serious damages if not attended to. The collapse of two major structures in 1996, the outfall structure of Balloki-Sulemanki Link Canal and regulator structure of Marala-Ravi Link Canal, raised serious concerns about state of health of system. The Irrigation Department,

therefore, undertook a diagnostic study for assessing the adequacy and safety of the hydraulic structures through Engineering Consulting Firms (PID/IRI, 1998). The recent damages to the downstream cistern and aprons of Jinnah Barrage due to excessive downstream retrogression has caused deep concern regarding safety of the barrages, which are the most important component of our irrigation network. Surface and sub-surface problems have also been reported from a number of other barrages like Taunsa, Chashma, Balloki, Sulemanki, Panjnad, Islam and Rasul. Similarly reconstruction of Khanki Weir, which was commissioned in 1892, has also been indicated on priority.

The broad categories for damages / deficiencies in the irrigation structures and canals include:

- a) design related deficiencies
- b) changes in operating conditions
- c) serious retrogression downstream of barrages
- d) deferred maintenance
- e) aging process
- f) hydraulic / structural and mechanical problems

The system management has also suffered serious setback due to progressive deterioration of the canal communication network and lack of adequate transport facilities. As a consequence, communication black-outs between the managers and operators severely hamper the management capability to respond effectively to the field problems / emergencies.

## **POLICY FRAMEWORK FOR ADDRESSING THE CONSTRAINTS**

In order to address the complex irrigation management issues comprehensive and integrated improvement strategies need to be conceived and evolved. Isolated interventions are neither expected to transform the system performance to any great extent nor would these bring about sustainable improvements in the system management. For instance, it appears unlikely that merely changing the institutional framework or fiscal policies in isolation, without addressing the physical constraints, can significantly improve the system performance. This brings to focus the need to appreciate and consider all the complex and diverse issues that impinge on irrigation management (Haq, 1998).

The holistic set of policy interventions that need to be conceived and implemented include structural measures for addressing the physical constructions of the system and management interventions to enhance the irrigation performance. The main thrust and status of the proposed policy interventions is presented in Box-2.

<b>BOX-2</b>			
<b>POLICY / STRATEGIC INTERVENTIONS</b>			
<b>Policy / Strategic Interventions</b>	<b>Sector / Sub Sector</b>	<b>Main Thrust</b>	<b>Status</b>
Emergent System Rehabilitation and Modernization	Irrigation	Rehabilitation and up-gradation of irrigation canals and barrages to ensure sustained operations and to meet the future demands.	Being Planned
Institutional Reforms	Water/Irrigation	Improving the governance and management of water / irrigation sector with focus on holistic planning, participatory management and sustainability.	On-going
Optimal Harnessing of River Flows	Water/Irrigation	Priority planning and implementation of new reservoir projects for effective utilization of surface water resources.	Being Planned
Canal Water Operation Planing	Irrigation	To improve Canal Water Operation, Plans through input of Agriculture Department / WACs	Being Implemented.
Dis-investment of Public FGW Tubewells	GW/Drainage	Relieving the Public Sector of the O&M Costs for the FGW SCARP Tubewells	Being Implemented.
Ground Water Management Framework	Ground Water	Developing a comprehensive management regulatory and framework for optimizing the sustainable use of Ground Water.	Being Designed.
Environmental Protection Strategies	Irrigation/ Drainage	To adopt legal and institutional measures for maintaining the quality of provincial water resources at environmentally acceptable levels.	Being planned.
Optimizing Irrigation Water Allocations	Irrigation	Review of the current canal water allocations in order to optimize resource use in a conjunctive and participatory management mode.	Study under NDP being launched.
Alternative Rate Mechanisms	Irrigation	Review of various modes of assessment to bring about transparency, economy and ease in assessment. Redefine assessment and collection costs.	Under Consideration pilot FOs. Comprehensive study under NDP.
Global Water Law	Water/Irrigation	To replace a no. of existing legislations regarding water issues and to develop a comprehensive Water Law in keeping with current and future requirements as well as to support the process of institutional reforms.	Concept framework under consideration
Financing the Drainage and Flood Costs	Drainage/Flood	Review/Recommend implement -able measures for financing the O&M cost of drainage and flood sectors.	To be studied under NDP.

### SYSTEM REHABILITATION / IMPROVEMENT NEEDS

As already discussed, the irrigation system of Punjab has deteriorated over time and has become fragile and prone to failures. Indeed, some of the major structures failed in the recent past causing stoppage of irrigation water to large areas with huge economic losses. Recent surveys have revealed that numerous important hydraulic structures, including barrages and canal head-works, are in precarious state and the need for rehabilitation is urgent. Besides rehabilitation, the system also needs improvements to meet the future needs and to allow its efficient operation. The overall rehabilitation / improvement needs for canal Irrigation Infrastructure, is presented in Box-3 (PID, 2000).

<b>BOX - 3</b>		
<b>PUNJAB's OVERALL REHABILITATION / IMPROVEMENT NEEDS</b>		
<b>Sr. No.</b>	<b>Program Component</b>	<b>Indicative Cost (Billion Rs)</b>
<b>I.</b>	<b>Canal Infrastructure</b>	
i)	Canal Remodelling / Modernization	50.00
ii)	Renovation of Structures	20.00
iii)	Barrage Remodelling / Modernization	30.00
iv)	Selective Canal Lining in SGW Areas	10.00
v)	Communication / MIS	1.50
vi)	Training and Human Resources Development	0.50
	<b>Total (I)</b>	<b>112.00</b>
<b>II.</b>	<b>Drainage Rehabilitation / Improvements</b>	<b>20 to 30</b>
<b>III.</b>	<b>Flood Protection</b>	<b>10 - 20</b>

### THE FINANCING OPTIONS

While the on-going National Drainage Program and Second Flood Protection Project provide investments for phased improvement / up-gradation of the Drainage and Flood Protection Infrastructure, there are no on-going projects at the moment for improvement / modernization of the canal infrastructure. The possible options for financing the needed improvements include: funding through ADP, mobilizing additional local resources, fund – raising through local capital markets, and arranging foreign assistance through multilateral donors. These financing options are discussed hereunder:

- i) **Financing through ADP.** The Water Sector Provincial ADP is already over-stretched with annual allocation of around Rs 1–1.3 Billion, which may not be adequate even to expeditiously complete the on-going ADP schemes. Substantial additional allocations may be difficult to manage from Provincial ADP. Allocations have been indicated in the next 10 years Perspective Plan under Federal Public Sector Development Program for barrage modernization. The funding however is not assured because of ambitious nature of the plan and lack of firm funding commitment.

- ii) **Mobilizing Additional Local Resources.** Mobilizing additional local resources for financing the needed Water Sector investments has been under consideration for quite some time. This option would help in rationalizing the design of interventions to economize costs, in fast-tracking the implementation process and in achieving the desired goal of long-term sustainability.

In order to implement the alternative of mobilizing local resources, a dedicated 'Development Fund' may be setup for financing the rehabilitation and up-gradation cost of irrigation network. The following options could be considered for generating funds for the purpose:

- a) Transferring an agreed part of the Agriculture Tax receipts to the above Fund (Rs 500 – 750 Million per annum). The plausible argument in this regard is that the Agriculture Tax proceeds should be ploughed back into the sector from which these have been generated and for the activities which require them most urgently.
  - b) The royalty from the completed and on-going hydel projects could generate quite a handsome amount (upto Rs 1 Billion annually). This would however require policy level support and deliberations with Federal Government /WAPDA.
  - c) Imposition of development cess on per acre of CCA basis (say Rs 100 per acre per annum) which could be recovered with the abiana dues during Kharif and Rabi season [eg. Kharif: Rs 60 and Rabi Rs 40 per acre]. This could generate about Rs 2 Billion annually. The current abiana rates are highly subsidized and farmers can afford to pay the proposed cess without seriously affecting the farm budgets. It is worth pointing out that farmers spend about ten times more for groundwater extraction to supplement the canal supplies. The marketing systems however need to be rationalized for providing a level play-field to the farming community and to stabilize their farm income.
- iii) **Public Private Partnership.** The public - private sector partnership is a potential financing window that can be progressively developed by mobilizing the support of the local investors, farming community and the Districts Governments. Appropriately designed projects with active participation of all the stakeholders and demonstration of their beneficial impacts could gradually promote investments by the private sector. This would however require adoption of comprehensive policies for incentives, development of grass root organizations, and adoption of transparent systems of implementation.
- iv) **Fund Raising through Local Capital Markets.** Given the kind of high interest rates and unpredictable / uncertain environment in which the local capital markets operate, it appears unlikely that firstly the needed resources could be mobilized from

local markets and secondly that the financing option could be viable from the viewpoint of financial sustainability.

- v) **Foreign Assistance.** Financing of the needed investments in Water Sector through foreign assistance holds promise, particularly if concessional credits / loans are available. The multilateral aiding agencies had previously indicated their willingness for financing the Barrage Modernization and Irrigation System Improvement Projects, but the processing of financial assistance got stalled due to lack of agreement on policy issues. As a result of the recent changes in the geo-political situation, there are indications that a number of multi-lateral donors may revive their plans and programs for supporting development efforts in the water sector projects of the county.

The option is however dependent on the broader policies of the donor agencies, which can and do change in the backdrop of a dynamic geo-political situation. The other issues which need to be carefully considered in the context of foreign assistance include donor's policy dictates, lengthy procedures, expensive consultants and costly project designs. The recent implementation experience of National Drainage Program, Marala Ravi Project and Second Flood Protection Sector Project has brought these issues to sharper focus.

## CONCLUDING COMMENTS AND RECOMMENDATIONS

The following conclusions and recommendations are made for addressing the emerging challenges of sustenance of irrigated infrastructure:

- The need for rehabilitation and up-gradation of our aging irrigation system has become imperative to sustain the resource base that is critical for agriculture and national economy. The initial estimates indicate quite substantial funding requirements (Rs. 100 - 150 Billion) for the purpose. In view of the vital importance of the interventions, there is a need to conduct a comprehensive master planning study for firming up the investment requirements and the implementation priorities.
- There is a need to take the basic policy decision regarding the scope and extent of improvements to be undertaken and the size of investments to be made. The implementation alternatives for irrigation system renovation may include the following:
  - Emergency Repairs Mode, Minimum Investments of Rs. 1 - 1.5 Billion per annum for addressing just the emergency repairs needs of irrigation network.
  - Rehabilitation Mode, Moderate Investments of Rs. 2 - 3 Billion per annum mainly for addressing the rehabilitation needs of the system with only limited up-gradation in a phased manner.
  - Modernization Mode, Intensive Investments of Rs. 4 - 6 Billion per annum for up-gradation and modernization of the irrigation network to enable it to face the challenges of the 21<sup>st</sup> Century.
- Strategic decision also needs to be taken regarding the financing pattern for supporting the required investments in the Water Sector. The possible options in this regard include funding through ADP, mobilizing local resources through additional

taxation, fund raising through local capital markets and / or arranging foreign assistance through multi-lateral donors. Efforts need to be made to evolve a balanced mix of local resources and foreign assistance. The most important considerations in this regard should be cost and resource optimization, sustainability and overall national interests.

- The Government support is essential for gradual and phased implementation of the reforms agenda in Water Sector with focus on better governance, decentralization and participatory management. The reforms consistent with local setting, are not only essential for optimizing irrigation management, but they are also needed for supporting the investment requirement of an aging and deteriorating physical infrastructure.
- The issues of physical and financial sustainability of irrigation infrastructures are assuming increasing importance. Appropriate policy interventions therefore need to be taken for addressing the sustainability concerns in an effective and efficient manner. These may include adequate O&M funding and its optimal utilization for sustained upkeep of the constructed facilities and measures for rationalizing the expenditures and enhancing the incomes.
- Comprehensive and holistic policies need to be evolved for optimizing water resources management. This would require formulation of National Water Policy and Water Sector Strategies. High-level Policy Committees and multi-disciplinary Think Tank Cells need to be established both at the national as well provincial levels for guiding the policy formulation and steering the implementation process to achieve the objectives of water resources development and its integration with the ultimate goal of the overall national development.

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