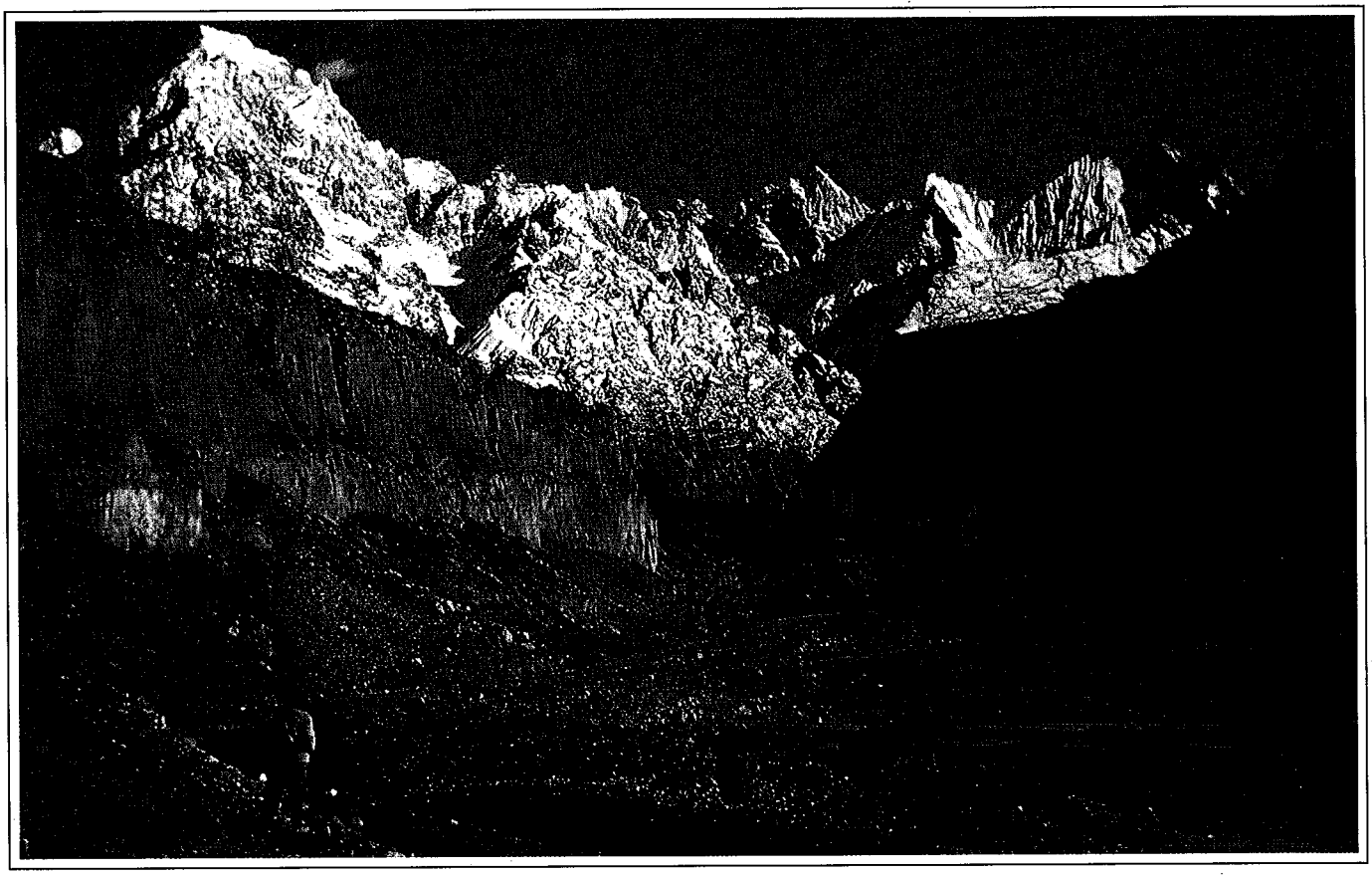

*Traditional **kuhl** mountain channel, Gilgit. Pakistan's mountains hold the world's biggest stores of snow and ice outside polar regions.*

Managing Indus Water — A Whole Basin Approach

by S.S. Kirmani

Pakistan is blessed with rich water resources. The great Himalayan ranges dominate the weather, trap the monsoons and regulate the water cycle. The Himalayan watershed of the Indus and its tributaries includes the biggest glaciers outside polar regions and 44 of the world's 100 highest mountains.

Surveys of the 56-km Baltoro Glacier in the Shyok valley, have indicated it may store 120 billion cubic meters of water. Other large and small glaciers and icefields may hold more than 1,200 billion cubic meters. The major dam basins of Tarbela and Mangla are miniscule by comparison at a capacity of 18 billion cubic meters.

Porous rock and gravel formations that have accumulated where the river and its tributaries dissect the lower Himalayan and Siwalik ranges, store part of the monsoon rainfall for a time and feed the streams and rivers in the dry season. The capacity of this natural reservoir once amounted to more than 12 billion cubic meters but deforestation has reduced it, increasing flood and sedimentation hazards downstream. Watershed management to restore storage capacity has produced encouraging results in the Mangla Reservoir catchment.

The vast Indus Plains are underlain by sandy alluvium to depths of up to 300 meters and form a huge and highly transmissive aquifer system with a usable storage volume of free water much greater than all the existing and potential storage reservoirs on the Indus and its tributaries. Annual recharge to this groundwater reservoir is more than 56 billion cubic meters, of which some 45 billion cubic meters are usable. Although extensive development has taken place, there is potential for nearly 10 billion cubic meters extra abstraction without overdrawing. However, effective management is essential to maintain water quality on a sustainable basis.

Wide alluvial river channels in the Indus Plains (combined length 3,500-km) also serve as natural reservoirs and flow regulators. During high river stages, channels are filled, flood peaks are moderated and water seeps into the banks. When the river drops, channel storage is released and water stored in the banks seeps out as return

flows. Releases from channel storage (3.5 billion cubic meters) take place throughout the *rabi* growing season (roughly mid-October to mid-April in Punjab, earlier in Sindh Province). Timing and quality of these releases are determined by man-made interventions in the rivers and storage reservoirs. Effective management to prevent deterioration is essential to husband gains from this natural storage.

It is time our engineers learned more about these immense water resources and natural reservoirs. Managed comprehensively, they will provide more water for productive use than many seem to imagine.

Pakistan ranks fifth in the world and third among developing countries in size of irrigated area. Around 25 percent of its territory is currently cultivated, 20 percent under irrigation.

International Food Policy Research Institute studies suggest Pakistan and Thailand are the only two countries in Asia that could export food on a sustainable basis in the next century. The studies emphasize, however, that the key to realizing this potential lies in improving current water and farm management practices, and agricultural inputs and services.

Agriculture is the livelihood of over 50 percent of Pakistan's 110 million population and is the most productive sector of the economy. From 1962 to 1982, agricultural production grew at an average annual rate of 4 percent, varying from 6 percent in the 1960s to 2 percent in the early 1970s. During the Sixth Five Year Plan (1984-88), average growth increased by 4 percent, owing largely to an increase of 10 percent in the production of cotton.

Though agricultural production increased dramatically in the "Green Revolution" years of the sixties, Pakistan was unable to sustain growth and is currently struggling to achieve self-sufficiency in food. Edible oil imports are skyrocketing. Against the targeted growth rates of 4.45 percent for wheat and 4.07 percent for rice of the Sixth Five Year Plan, achievements were 0.43 percent and minus 1.19 percent, respectively. Except for cotton, growth rates of all crops have stuck among the lowest in developing countries.

Between 1977 and 1988, irrigated wheat yields increased at an annual growth rate of 1.9 percent and IRRI rice at 0.9 percent, but World Bank data reveal that growth between 1984-88 stagnated, despite significant increases in farmgate water supplies (23%) and irrigated area (14%).

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At the heart of disputes over water apportionment lay a fear that there would not be enough water in the rivers to meet future needs. Such fears were justified when canal withdrawals were based on run-of-the-river supplies and crops were doomed if the system ran dry.

Today, however, surface water and groundwater storage reservoirs and inter-river link canals provide means to match water supplies closely to crop needs.

Past disputes caused an annual economic loss of almost a billion rupees. Benefits forgone were greater still. An increase of one to three percent of water supply to offset a shortage in critical months would have given a dramatic boost to crop yields.

Pakistan has more land than water and the ultimate constraint on future growth will be water, not land. However, Pakistan has more water and more irrigation than most countries and it has a great deal more of both than it is using efficiently and productively.

Pakistan is threatened by unsustainable withdrawals from surface water and groundwater resources alike. The quality of groundwater is deteriorating due to the lack of adequate arrangements for disposal of saline effluent. The cost of new water development projects is increasing and problems will continue to multiply if the practice of managing the basin's resources as separate and unrelated parts continues.

The Indus Basin is a single hydrological unit. Its surface water and groundwater resources are interrelated and constitute a single system.

If the saline water from the basin is not disposed of to the sea, it can adversely affect the quality of its useful groundwater resources. If dumped in the rivers, it would affect the quality of the river supplies. And if adequate fresh water is not released below Kotri, salt intrusion from the sea would affect the environment of the Indus Delta.

Any action that disturbs the natural conditions of the surface water and groundwater resources in one part of the basin has an impact on the rest. Integrated, comprehensive management (ICM) of the basin's resources is essential to optimize positive impacts and reduce negative effects to an acceptable level.

Although ICM of "water resources" and water management are

terms that are sometimes used interchangeably, there are differences. ICM is designed to ensure efficient, equitable and productive use of water resources basin-wide and to provide adequate quantities of good quality water to all competing users at a decent cost. It addresses such issues as adequacy of hydrological data, watershed management, resource planning techniques, water use policies and practices, operations and maintenance, environmental protection, research and technology, water pricing and cost recovery.

There are compelling reasons why ICM of water resources must be the way forward for Pakistan. We have the largest single contiguous irrigation system in the world, its resources are remarkably diverse, the environmental problems are formidable and the economy depends largely on irrigated farming.

ICM is not new. The Punjab was the locale where it was conceived and first practiced. The Triple Canal Project of the early 1900s, the Haveli Canal of 1935 and the Link Canals of the Indus Basin Project in the late 1950s were highly effective measures toward integrated management of irrigation water to boost productivity on a grand scale.

But this vision has given way to disputes and a race to establish water rights through increased canal withdrawals by Provincial Irrigation Departments.

Mangla and Tarbela are operated as separate and unrelated reservoirs instead of the twin engines of crop and power production they were meant to be. The Jhelum-Chenab and Indus zones are run as independent hydrological systems. Groundwater resources have been developed extensively during the past 25 years,

Pakistan's farmers use and trade tubewell water to gain flexibility which canal supplies too often limit.

but canals are being operated as if groundwater does not exist.

Farmers are wiser. They use canal water and groundwater conjunctively to bolster crop yields and sell water to neighbors who do not have tubewells. However, the scope of such conjunctive use is limited and the potential for extending it system-wide has not been realized.

Water surplus in canal systems in one province could be shared with others at an agreed price. Or water accounts could be kept so transactions are balanced over time, especially in dry years when river supplies are short and mining of groundwater for short periods is feasible.

A growing body of scientists is warning of imminent climatic changes due to buildup of carbon dioxide and other greenhouse gases in the atmosphere. Like a one-way filter, greenhouse gases allow the sun's energy to pass through the atmosphere but trap reflected heat energy. Though the effect is not fully understood, it could have a major hydrological impact on the melting of high mountain snowpeaks and may result in seasonal changes in runoff.

If worldwide climatic changes occur as predicted, new management approaches may be necessary to keep water flowing in the Indus Basin.

Pakistan cannot afford to delay the integrated comprehensive management of the Indus Basin's resources which should be declared a priority objective of water policy. Establishing — and implementing— this policy will require commitment and courage. Success must lie in reorienting the focus of water sector institutions from water to crops and from exclusive concern for water rights to concern for optimizing production without losing water rights. Implementing ICM policies also means enhancing the capacity and capabilities of water sector institutions to address management issues confidently and well.

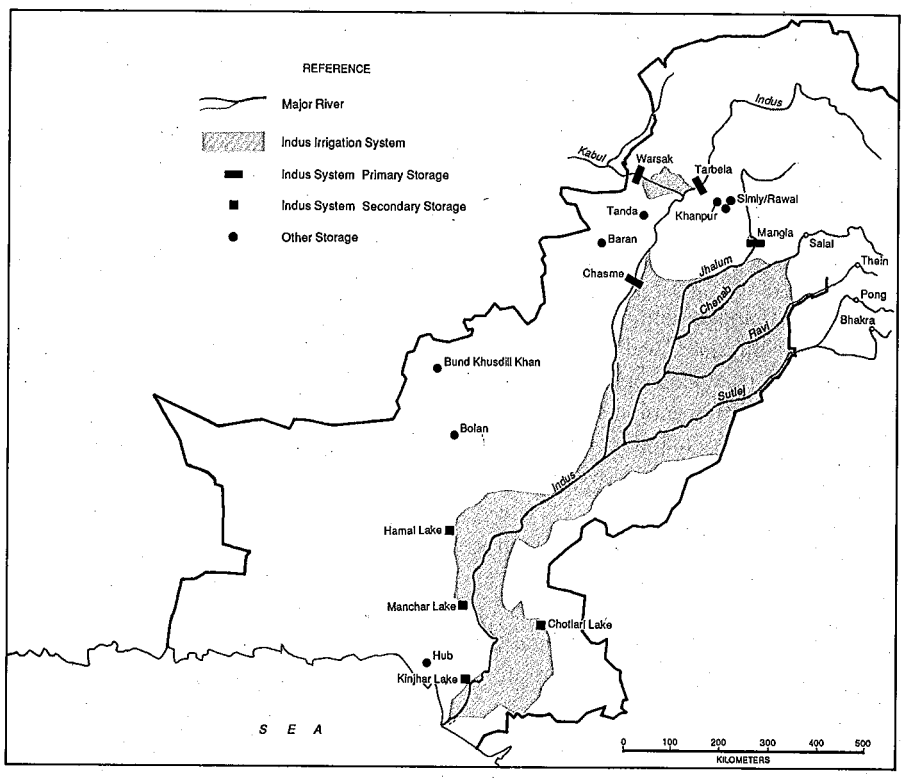
GIANT AMONG SYSTEMS

The irrigated area of the Indus Basin frames one of the largest contiguous irrigation systems (and one of the largest engineered artifacts) in the world, covering more than 16 million hectares and crossing nine agroclimatic zones. There are 3 major storage reservoirs, including possibly the world's biggest earth-filled dam (Tarbela), 19 barrages, 12 inter-river link canals, 59,500 kilometers of canals and about two million kilometers of watercourses and field channels.

Major canal command areas number 43, *chaks* (watercourse commands) 95,000 and there are 16,000 kilometers of surface drains. In addition, the irrigation infrastructure includes 12,500 large public tubewells, over 250,000 small tubewells and nearly 16,000 kilometers of surface drains.

Pakistan's total land area is 793,000 square kilometers, of which 192,000 are cultivated. Punjab has the largest cultivated area (122,500 square kilometers), followed by Sindh (37,000), North-West Frontier Province (17,000) and Baluchistan (16,000 square kilometers).

According to recent Water and Power Development Authority (WAPDA) and World Bank figures, ongoing federally funded works of extension, improvement or construction of canals and drainage or reclamation schemes in Pakistan could, if they perform up to expectations, provide around 60 percent of the incremental growth in production capacity required to keep up with the demographic growth rate and growing food demand — about 2.7 percent a year, or virtually a doubling of present food production over the next ten years. The 1.5 percent deficit will have to be made up by increases in irrigated area, strategic use of groundwater and other means requiring new management approaches.



Indus Irrigation System and Surface Storage.

Farmers install a turnout as part of watercourse improvement efforts by a Water Users' Association.