



A PRODUCTIVE AND WATER-SECURE PAKISTAN

• INFRASTRUCTURE • INSTITUTIONS • STRATEGY

THE REPORT OF THE WATER SECTOR TASK FORCE OF
THE FRIENDS OF DEMOCRATIC PAKISTAN

2012

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Acknowledgements

The Friends of Democratic Pakistan (FODP), a group of countries that aim to support the Government of Pakistan in its efforts to consolidate democracy in Pakistan and support social and economic development in the country, held its Third Ministerial Meeting in Brussels on 15 October 2010. The meeting participants acknowledged water resources as a priority for the country and agreed that an FODP Water Sector Task Force (WSTF) should be established to prepare a report on the water sector, including an action plan, in consultation with the Government of Pakistan. The report would take into account all aspects of water resources and its critical importance to the country's overall economic development, food security and health of the population.

Preparation of this report was overseen by a Steering Committee co-chaired by the Secretary of the Ministry of Water and Power and the Country Director of the Asian Development Bank (ADB). Members of the Steering Committee included representatives from the federal government (including the federally-administered special areas), provincial governments, and the governments of Australia, Canada, France, Germany, Japan, the Netherlands, Norway, the United States of America, and the United Nations through UNESCO. The ADB established a WSTF secretariat to which a renowned team of international and national experts were seconded by the FODP to prepare the report. The report preparation process included extensive consultations with key public and private-sector stakeholders throughout the country.

The FODP WSTF expresses appreciation to the Government of Pakistan for the support and guidance provided to the secretariat in preparing this report. Federal and provincial government ministries, departments, agencies, and other public and private sector stakeholders actively participated in and contributed to the process by generously sharing their time and information with the secretariat. The WSTF also expresses its gratitude to the FODP countries that provided financial support and technical experts to the secretariat, with special thanks to all members of the FODP WSTF for their valuable contributions and inputs into this report.

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Abbreviations and Acronyms

ADB	Asian Development Bank	NDP	National Drainage Program
AJK	Azad Government of the State of Jammu & Kashmir	NDMP	National Disaster Management Plan
AWB	area water board	NEPRA	National Electric Power Regulatory Authority
CCI	Council of Common Interest	NFPP	National Flood Protection Plan
Cfs	cubic feet per second	NGO	nongovernment organization
CWR	crop water requirements	NPV	net present value
DRM	national disaster risk management framework	NRW	non-revenue water
FATA	Federally Administered Tribal Areas	NWI	National Water Initiative
FFC	Federal Flood Commission	O&M	operations and maintenance
FODP	Friends of Democratic Pakistan	OFWM	on-farm water management
GDP	gross domestic product	P&D	planning and development departments
GLOF	glacial lake outburst floods	PARC	Pakistan Agricultural Research Council
HEC	Higher Education Commission	PDMA	provincial disaster management authority
HKH	Himalayan Karakorum Hindu Kush mountains	PHED	Public Health Engineering Department
HUD	Housing and Urban Development	PID	provincial irrigation department
IBIS	Indus Basin Irrigation System	PIDA	Punjab Irrigation and Drainage Authority
ICHARM	International Centre for Water Hazard and Risk Management	PMD	Pakistan Meteorological Department
ICIMOD	International Centre for Integrated Mountain Development	PPP	public private partnership
IFC	International Finance Corporation	PRC	People's Republic of China
IFI	international financial institutions	PRs	Pakistan Rupees
IFM	integrated flood management	RFP	request for proposal
IWE	Institute for Water Education	ROR	run of the river
IT	information technology	SIDA	Sindh Irrigation and Drainage Authority
IRR	internal rate of return	SUPARCO	Space and Upper Atmosphere Research Commission
IRSA	Indus River System Authority	Twh	terawatt hours
JICA	Japan International Cooperation Agency	UNESCO	United Nations Educational, Scientific and Cultural Organization
Kwh	kilowatt hour	USA	United States of America
KW&SB	Karachi Water and Sewerage Board	WAPDA	Water and Power Development Authority
LBOD	Left Bank Outfall Drain	WASA	water and sanitation agency
MAF	million acre feet	WCAP	Water Sector Capacity Building and Advisory Services Project
MOWP	Ministry of Water and Power	WSTF	Water Sector Task Force
MW	megawatt	WUA	water user association
NDMA	National Disaster Management Authority		

Glossary

<i>Abiana</i>	Water charges
<i>Barani</i>	Rain-fed agriculture
<i>dhands</i>	Wetlands in Sindh province
<i>dhoras</i>	Natural old river courses
<i>Disty</i>	Distributary canal
<i>Kareze</i>	Underground water channel
<i>Kharif</i>	Summer growing season
<i>Mogha</i>	Canal outlet
<i>Nacca</i>	outlet from water course to field
<i>Rabi</i>	Winter growing season
<i>Warabandi</i>	The amount of irrigated water allocated per farm

Note 1

In this report, \$ means United States dollar.

Note 2

All references to years e.g. 2010-2011 mean a one-year period from July to June.



EXECUTIVE SUMMARY

Pakistan is a country built around the waters of the Indus River Basin. The water resource base of the country is under grave and growing stress – from the expanding population and the demands of growing cities and industry, from increasing scarcity, from degradation of water quality, from climate change, and above all, from the recurring inability to develop an adequate platform of modern infrastructure and institutions. Pakistan stands at a crossroads. Continuing business as usual will compromise food, energy and income security with ominous implications for poverty and conflict. On the other hand, there is a broad consensus that there is another imaginable future: one in which a modern portfolio of hard-ware and soft-ware could constitute the basis for a productive and water-secure country. It is entirely conceivable that Pakistan could do the following:

- double the value of its agricultural outputs thus assuring food and income security and making it a regional agricultural powerhouse;
- triple the output of clean, climate-friendly, low-cost hydropower;
- reduce by half the areas adversely affected by major floods, and reduce even more the human and economic impact of such events; and
- provide all urban residents with continuous, safe water supplied by self-financing utilities and treat all industrial and a substantial portion of domestic wastewater thus improving the health of city-dwellers and of the rural communities currently assailed by large flows of untreated wastes.

This report was done by a task force which reported to the Government of Pakistan and the Friends of Democratic Pakistan (FODP) and is designed to mobilize the financial and intellectual resources of the federal government, the provincial governments, the private sector and Pakistan's development partners to work together to take the first steps to secure this productive, water-secure future.

A steering committee (comprising the federal and provincial governments and FODP members) gave the FODP the following instructions:

- Build on the large amount of prior analytic work on water in Pakistan by the federal and provincial governments and others and do not attempt to repeat that work.
- Rigorously focus only on the highest priority items.
- Develop action plans that take sequencing into account.
- Interact extensively with federal and provincial leaders so that recommendations are made primarily in areas where there is a willingness to act.
- Explicitly describe the roles of federal and provincial governments moving forward.

- Make specific recommendations for critical support that must be provided by FODP if progress is to be made.

The draft findings of the water sector task force (WSTF) were discussed with a large group of diverse (geographical and institutional) stakeholders in Islamabad in December 2011. The institutional composition of the stakeholder group and their overall judgment on the diagnosis and recommendations are shown in Summary figure 1 and Summary figure 2.

The WSTF solicited and welcomed comments on drafts of the report from the federal and provincial governments and many other stakeholders. All of the comments were informative and read carefully. In many instances the suggestions were incorporated into the final report. In a number of cases the WSTF either did not agree with the suggestions, or there were different suggestions from different stakeholders. In cases where there was not agreement, the recommendations of the WSTF reflect the judgment of the WSTF members, in light of international experience and its assessment of the facts in Pakistan.

This report highlights five major areas in which immediate action is a high priority.

- After a disastrous hiatus of 40 years, start constructing large storage dams on the major rivers, and modernize the national policies and institutions that govern the use of their waters.
- Invest in modernizing the institutional arrangements and infrastructure required to raise the abysmal level of agricultural output, and turn Pakistan into a regional agricultural powerhouse.
- Invest in infrastructure and institutions for more effective and equitable arrangements for living better with floods.
- Modernize institutional arrangements and invest in the water and sewerage services necessary for productive, healthy cities.
- Establish the knowledge base needed to develop and manage one of the largest and most complex water systems in the world.

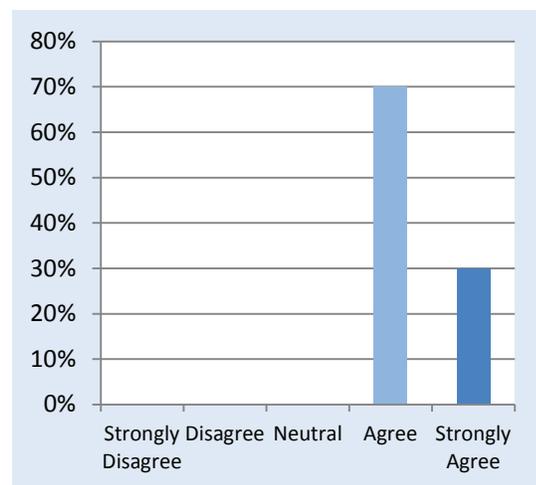
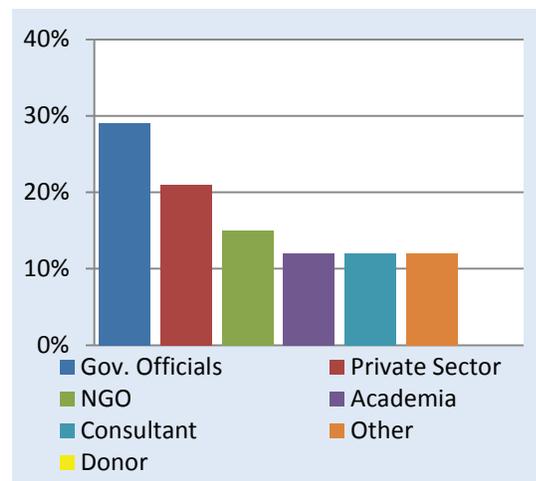


Figure 1 (Top): Who attended the December 2011 Stakeholders' Workshop?

Figure 2 (Above): Stakeholders' Overall Assessment of the WSTF Report

The Summary Table provides an overview of the main recommendations of the WSTE.

Summary Table: Recommended Actions, Responsibilities and Costs

No.	Action/Project	Objective	Primary Responsibility	Time Line	Indicative Financing (\$million)
1. MAJOR INFRASTRUCTURE AND ASSOCIATED INSTITUTIONS					
1.1	Rehabilitation of 3 major barrages	System sustainability	provincial irrigation departments (PIDs)	2012-2016	\$400.0
1.2	Basha Dam in Gilgit Baltistan	Hydropower and irrigation	WAPDA	2011-2020	\$12,000
1.3	Kurram Tangi, Munda, Dasu, Kohala, Golen Gol, Bunji	Flood control and hydropower	WAPDA	2011 - 2020	\$14,000
1.4	IRSA Reforms	Increase transparency and predictability, and reduce conflict	IRSA	2012-2013	\$3
1.5	Revenue-sharing framework	Enhance equity and project acceptance	MOWP	2012-2013	\$1
1.6	Resettlement framework and capacity	Enhance equity and project acceptance	WAPDA	2012-2013	\$2
1.7	Environmental flows, especially in the Indus Delta	Sustainability and equity	IRSA, provinces	2012-2013	\$150
2. RAISING AGRICULTURAL PRODUCTIVITY					
2.1	On-farm water management	Increase agricultural productivity	Provincial agriculture departments, AJK, FATA, Gilgit-Baltistan	2012-2016	\$560
2.2	Public –private partnerships (PPPs) for small and medium dams	Increase agricultural productivity	Provincial irrigation and agriculture departments , AJK, FATA, Gilgit-Baltistan	2012-2016	\$460
2.3	Improved management of main canals	Increase agricultural productivity	PIDs	2012-2016	\$500
2.4	Spate irrigation	Increase agricultural productivity	Provincial agricultural departments, FATA	2012-2016	\$300
2.5	Optimal but judicious use of groundwater	Sustainable productivity	Provincial agricultural departments, FATA	2012-2016	\$ 100
3. LIVING WITH FLOODS					
3.1	Construction on new dams (see Item #1 above)	Reducing flood peaks	WAPDA	2012-2020	Included in #1
3.2	Long-term institutional development by partnership with an organization which has been successful (eg. the Mississippi River Commission)	Capacity building	FFC and the provinces	2012-2016	\$20
3.3	Key elements of the National Flood Protection Plan IV (2008-2017), including: <ul style="list-style-type: none"> • Floodplain zoning and enforcement • Early warning systems • Community-based disaster risk management • Flood protection Infrastructure 	Pre-, during and post-flood management	FFC , Pakistan Meteorological Department (PMD), national and provincial disaster management agencies, WAPDA, AJK, FATA, Gilgit-Baltistan, and provincial governments	2012-2016	\$500
3.4	Some federal and provincial actions including: <ul style="list-style-type: none"> • Asset Management Plans • Rehabilitation and maintenance of existing infrastructure and new construction 	Rehabilitation and maintenance of flood protection schemes (including spurs and bunds), estimated at \$500 million by the FFC	Provinces, AJK, FATA, Gilgit-Baltistan	2012-2016	\$500-\$600

No.	Action/Project	Objective	Primary Responsibility	Time Line	Indicative Financing (\$million)
3.5	Watershed management in AJK, Gilgit-Baltistan, and Khyber Pakhtunkhwa (KP)	Reduce severity of hill floods and reduce erosion	Federal government, AJK, Gilgit-Baltistan, and KP	2012-2016	\$50
4. SUSTAINABLE URBAN SERVICES					
4.1	Automatic tariff revision	Improve financial sustainability	Provincial governments and WASAs	2012	No cost action
4.2	Start reducing non-revenue water (in 20 utilities)	Improve service quality and financial sustainability	WASAs	2012-2016	\$5
4.3	Defining groundwater entitlements and regulating groundwater abstraction	Secure resource base	Provincial governments	2012-2016	\$10
4.4	Punjab Municipal Water Act	A model for urban water reform	Provincial governments	2012-2016	\$4
4.5	Save Quetta Ground Water	Help secure the future of Quetta	Government of Balochistan	2012-2106	\$40
4.6	Finance "wedge" to get to sustainability	Sustainable services	Provincial governments	2012-2016	\$35 for one large city
4.7	Infrastructure for quality water services	Service quality	Provincial governments	2012-2016	Between \$250 and \$700 per large city
4.8	Pilot industrial pollution control projects	Environmental health	Provincial governments	2012-2106	\$50 million per city
5. KNOWLEDGE MANAGEMENT					
5.1	Partnership with an institution (like E-Water) to develop the architecture and culture which produces integrated, demand driven knowledge product	A consistent knowledge base for operations at different levels	MOWP, FFC, IRSA, WAPDA, PIDs	2012-2016	\$30
5.2	An operational simulation model for the Indus Basin	Management and investment decisions	WAPDA with PIDs	2012-2016	\$20
5.3	Knowledgebase for Groundwater management	Sustainability and productivity	MOWP, PIDs, FATA, SUPARCO	2012-2016	\$20
5.4	Other decision support systems for data sharing, canals, assets management and managing climate change	Operation of the 1991 Indus Water Accord and infrastructure, improved water productivity	PMD, IRSA, WAPDA, SUPARCO, PIDAs and PIDs	2012-2016	\$30
5.5	Capacity building for management and research	Developing capacity	Higher Education Commission, MOWP, Ministry of Science and Technology, standing committees of the National Assembly and Senate on water and power, universities and research institutions	2012-2016	\$15



INTRODUCTION

The Friends of Democratic Pakistan (FODP) is a group of countries that support the Government of Pakistan in its efforts to consolidate democracy and to support social and economic development in the country. In 2009, the FODP established the sector task force as a mechanism for (i) focusing on sectors critical for development, (ii) developing short-term action plans for addressing priorities within those sectors, (iii) developing those plans with the participation of both the Government of Pakistan and FODP, and (iv) laying the basis for accelerated, coherent action by the Government of Pakistan and its development partners.

The first task force was the energy sector task force. At the request of the government and FODP, the Asian Development Bank (ADB) acted as the secretariat, which included energy experts who were identified, and funded by FODP. The work was overseen by a steering committee comprising representatives from the government and the participating partner countries and chaired by the Secretary of Water and Power of Pakistan, and the country director of ADB. The energy sector task force presented its report to the third ministerial meeting of the FODP on 15 October 2010.

The government and FODP were pleased with both the process and the product and decided to constitute a second task force to focus on the related and equally central issue of water. Given the importance of water to the provinces, Pakistan was represented on the steering committee by both federal and provincial authorities. Once again ADB was asked to act as the secretariat, and once again ADB gave a technical assistance grant for the exercise. FODP again provided international and local experts to work on the water sector task force (WSTF). Work started in May 2011. The steering committee met in June to review the overall work plan, in July to review the initial diagnosis, in September to review initial recommendations, and in December to review a draft of the report. Also in December various stakeholders were consulted to get their views on both the diagnosis and recommendations.

In Pakistan, both the federal and provincial governments have important and complementary roles in water development and management. The federal government plays a major role in developing and managing large infrastructure and in administering the 1991 Indus Water Accord that defines how water is shared among the provinces. The provinces also have major roles – and considerable autonomy – in managing barrages, embankments, irrigation, and urban and rural water and sanitation services. Accordingly, the WSTF worked closely with federal ministries and agencies (like the Water and Power Development Authority [WAPDA], the Indus River Systems Authority [IRSA], and the Federal Flood Commission [FFC]) as well as with the provincial governments. When appropriate, the WSTF also consulted with the private sector, farmers groups, academia and civil society organizations.

A central element of the work was consultations of two different types. The first was to ensure that the report tapped the extensive knowledge about water held by institutions and individuals at all levels in Pakistan. These consultations were vital for outlining the primary areas of focus and for formulating technically promising recommendations. The second type of consultation acknowledged that a credible action plan is not only technical but is political as well. Technical analyses should help inform political and bureaucratic decision-making, but political leaders must consider a large number of sectors at any one time must take into account recommendations from various sector specialists, and must decide how and when to expend limited political capital to make reforms. The fact that a provincial chief minister may not want to make reforms in water management now does not mean the minister is wrong, but only that now is not the right time as other issues may have higher priority. Accordingly, this report distinguishes between recommendations that make technical sense and for which there is support from political and bureaucratic leaders, and recommendations that also make technical sense but that are currently not a priority.



THE PURPOSE OF THIS REPORT AND HOW THE WORK WAS DONE

There have been many excellent reports that have analyzed the water challenges facing Pakistan. They have been very useful because they have developed a widespread, albeit not unanimous, agreement on the nature of these challenges. This report builds on those prior reports without replicating them but aspires to be different in two major ways.

First, the focus of the FODP was to identify the highest-priority actions to be undertaken over the next few years. The emphasis was on setting priorities (understanding that if everything is a priority, nothing is) and on sequencing interventions in particular action areas. Second, the WSTF acknowledged that excellent technical work is not enough; the challenge is to find the intersection of technical quality and political will. Accordingly, the WSTF made a concerted effort to listen to how political leaders wished to spend their limited capital and to offer recommendations on how that capital could be most effectively deployed.

An important question pertains to mechanisms for implementing WSTF recommendations. After considerable discussion, the steering committee recognized that the role of the report was not to add another layer of accountability but was rather to stimulate and galvanize actions that would materialize through well-established, permanent decision-making mechanisms. Within the federal and provincial governments these include both sector-specific exercises (such as a potential National Water Initiative, discussed in Section IV) and multi-sector exercises such as the Five-Year Plan and federal and provincial budget processes. There are well-established mechanisms for making decisions with partners too (such as the country partnership strategies of the development banks). The WSTF will be valuable if it provides a road-map that influences these processes. The government and the FODP should assess the impact of the WSTF report after 2 years and 5 years and should draw some conclusions about the effectiveness of this type of instrument.

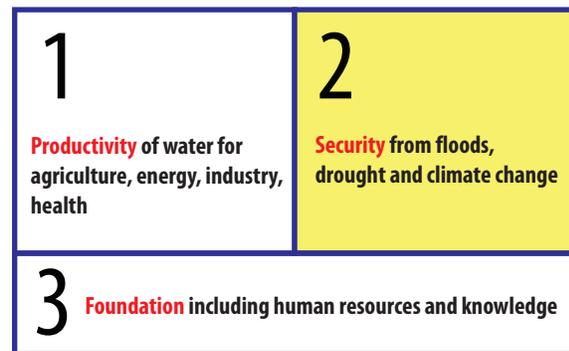
The work of the WSTF was based on the following premises.

- Pakistan, a country largely built on a single river system, faces grave water challenges.
- Water cannot be considered in isolation but rather as an essential element of income, food, energy, and physical security.
- Low water productivity and security are a root cause of poverty and conflict. The WSTF focused on actions that need to be taken now to enhance productivity and security.
- Improving productivity and security requires an integrated approach to institutions, infrastructure and the knowledge base.
- There are few examples where policy reforms takes place first and investments follow; and many where there is simultaneous, coordinated action on both the “soft” and “hard” fronts.
- As noted by a wise observer of global development practice, what separates countries that are advancing from those that are not is less the set of policies than the capacity to implement them. For decades, Pakistan has not been able to implement desperately-needed projects and policies. The primary objective of this report is to help break this deadlock and to help Pakistan and its development partners to focus on action.



SOLUTIONS FOR THE MOST PRESSING CHALLENGES

Pakistan faces almost every conceivable type of water challenge; the WSTF was formed to address the most pressing of these. The desired outcomes were reduced to three: a more water-productive Pakistan; a more water-secure Pakistan; and a more water-informed Pakistan (Figure 1).



The WSTF focused on solutions for the challenges offering the greatest threats (and opportunities) and on those on which action was both urgent and feasible:

1. building a platform of major infrastructure;
2. increasing water productivity in agriculture;
3. living better with floods;
4. improving institutions and infrastructure for productive and secure cities; and
5. building knowledge and capacity to manage one of the world's most complex water systems.

Figure 1: The WSTF conceptual framework

In each case, the WSTF did the following:

- collected and reviewed available information;
- met with responsible persons and affected groups;
- developed lists of recommendations for making improvements;
- culled the lists and focused on the highest priorities;
- sequenced the priority actions;
- assessed the political will to implement the recommendations;
- garnered reactions to the recommendations , through conversations and stakeholder workshops; and
- finalized the recommendations, specifying actions for federal and provincial governments and development partners.

A challenge for any report of this sort is to develop products that are useful for different audiences. To achieve this, the main report provides an overview of the main challenges and recommendations for political leaders and policy makers. Annexes 1-6 are intended for a more technical audience and go into more detail on the recommendations for each of the five solution areas.

BUILDING A PLATFORM OF MAJOR INFRASTRUCTURE

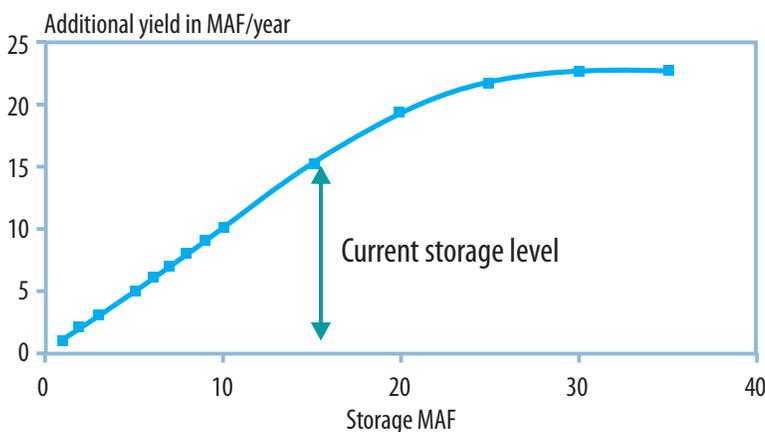
Diagnosis

Pakistan is, to a large degree, an arid country built around a single river. It is naturally an environment of extremes, with large seasonal and annual variations. About 70% of the flow in the upper Indus occurs in just 3 months of the year. Deserts with rivers flowing through them have long attracted civilizations because they offer huge opportunities for prosperity if the extremes of river flows can be managed.

In richer countries with rivers flowing through arid landscapes, many large dams have been built. In the Colorado River in the United States of America (USA), and in the Murray Darling River in Australia, reservoirs have the capacity to store about 1000 days of average flow. These serve as the water platform for both economic growth and for reducing insecurity emanating from droughts and floods.

The requirement for major storage in the Indus Basin has been clear since the founding of Pakistan. With the signing of the Indus Water Treaty in 1960, there was a political consensus within Pakistan and between Pakistan and its development partners on the urgent need for storage, both to attenuate the natural fluxes of the Indus and Jhelum rivers, and also to move water from the water-abundant west to the now water-starved east of the country. Tarbela Dam and Mangla Dam would, together, be able to store about 30 days of the combined average flow of the Indus, Chenab, and Jhelum rivers.

Figure 2: Storage Yield Curve for the Indus River



In concert with the engineering work on Tarbela and Mangla dams, the so-called “Liefink Report” of a distinguished team of Pakistani and international water experts traced out a long-term development path for the Indus Basin. Two technical elements were key: (a) because of the heavy sediment loads in rivers coming off the young Himalayas, live storage at existing dams would be steadily reduced over time and (b) the additional yield (in terms of assured usable flows) would increase sharply as additional live storage was created (in technical terms, because the storage/yield curve was still steep,

1. Annex 1 provides more details on this action area.

as shown in Figure 2). The rule of thumb for the Indus is that every additional million acre foot of storage creates an increased annual yield of a million acre feet (MAF) a year.

A second perspective was that hydropower could produce large quantities of clean, renewable energy at low cost. Again the expectation was that Pakistan would follow the path taken by rich countries that had substantial hydropower potential, all of which now have developed at least 70% of it.

Visionary leaders have long understood that there were not only large direct benefits from such investments, but that the indirect benefits (arising from backward linkages that relate to the supply of inputs into induced productive activities, and forward linkages from the processing of outputs), were also large. In the case of Tarbela Dam the direct benefits were substantially larger than predicted at project appraisal. In the Indus Basin in India the indirect benefits from Bhakra Dam (on the Sutlej River) have been about as great as the direct benefits and have transformed the regional economy. For Pakistan, the International Food Policy Research Institute has estimated even larger multipliers: – the total (direct and indirect) effect of a \$1.00 sales increase in agriculture as it multiplies through the economy is \$2.81 and for electricity (assumed to come from hydropower) the effect is \$2.74.

A central element in the Liefink Report was the understanding that Tarbela Dam and Mangla Dam were just the first steps in a long-term challenge to increase the proportion of the waters of the basin that could be controlled in reservoirs and to increase hydroelectricity. It was expected that a new reservoir the size of Tarbela Dam would have to be built every decade for the foreseeable future.

Unfortunately, 50 years later only two minor additions have been made: some additional hydropower generating capacity at Ghazi Barotha taking advantage of the regulating capacity of Tarbela Dam, and the recent raising of the Mangla Dam. For decades, a deadly combination of internal dissension and external prevarication precluded the building of new large dams. The roots of this conflict are in part a consequence of the economic and military development of Pakistan in colonial times and in part a consequence of “the iron law of perceptions on shared rivers” everywhere in which (in Australian parlance) “the downstreamers see the upstreamers as thieves, and the upstreamers see the downstreamers as complainers.”

In Pakistan this standard distrust was greatly exacerbated by three government policies. The first relates to decades of opacity in measuring what water was delivered to which provinces. The second relates to the distribution of profits from hydropower. The third relates to the sharing

(or not) of benefits with locally-affected people. The combination was paralyzing. The Council of Common Interests (CCI), the constitutional mechanism for addressing major federal-province issues, was never able to come to an agreement on building new storage on the Indus.

External partners have also played a negative role. In rich countries that have created endowments of major water infrastructure, there have been serious concerns about “going too far” with a broad perception that the small additional benefits of such infrastructure (marginal returns decline) are outweighed by environmental damage. Despite the fact that developing countries are at completely different points on the storage/flow axis, bilateral and multilateral financing agencies largely withdrew from financing “controversial” infrastructure. In rapidly growing countries (like Brazil and the People’s Republic of China [PRC]) this is not a problem because they have large internal resources. These countries have built and continue to build large dams, and now occupy a middle ground between rich countries like the USA and Australia that have over 5000 cubic meters of storage capacity per capita and countries like Pakistan with 100 cubic meters per person, or Ethiopia with 30 cubic meters. For countries without domestic financial resources, the withdrawal of development assistance for building dams has been devastating for both water productivity and security. Happily, some middle-income countries (especially the PRC, but also Brazil) are emerging as new partners to help poor countries build the necessary infrastructure, and at least some development agencies are returning to this business.

Priorities for Institutions and Policies

Water productivity and security requires integrated action on both software (laws, regulations, policies and institutions) and hardware. The lack of a fair, transparent approach to sharing the costs and benefits of water has been a major obstacle in developing high-return infrastructure in Pakistan.

There are, however, signs of progress – some in practice and some still under discussion – in laying a better institutional foundation for a fair, transparent approach to major infrastructure development and equitable sharing of benefits.

The Water Accord and the Indus River System Authority

The first issue relates to the sharing of water among the provinces. Good agreements are stable, predictable, and have the flexibility to make voluntary adjustments over time. Because there are legitimate but contending views from different parties, agreement on the principles for inter-provincial water sharing is difficult, everywhere. In this light, the 1991 Water Accord is a major achievement that neighboring countries have not been able to consummate. The WSTF agrees that the Accord should not be altered, and suggests ways in which the Accord could be implemented more effectively and harmoniously.

The Water Accord Itself

The water accord defines three distribution patterns for allocating water among the provinces as shown in Table 1. It is an imaginative blend of the two principles governing trans-boundary waters. The principle of “No Appreciable Harm” is applied to prior (historic) uses, and the “Principle of Equitable Utilization” is applied to both future water developed and to periods of abundant water availability.

Table 1: Distribution of flows in the 1991 Water Accord: Comparison of paras 14(b), 2 and 4 (percentages)

Province	Para 14(b)	Para 2	Para 4
1	2	3	4
Punjab	53.1	48.9	37
Sindh	42.2	42.6	37
Balochistan	1.6	3.4	12
KPK	3.0	5.1	14
Total	100.0	100.0	100.0

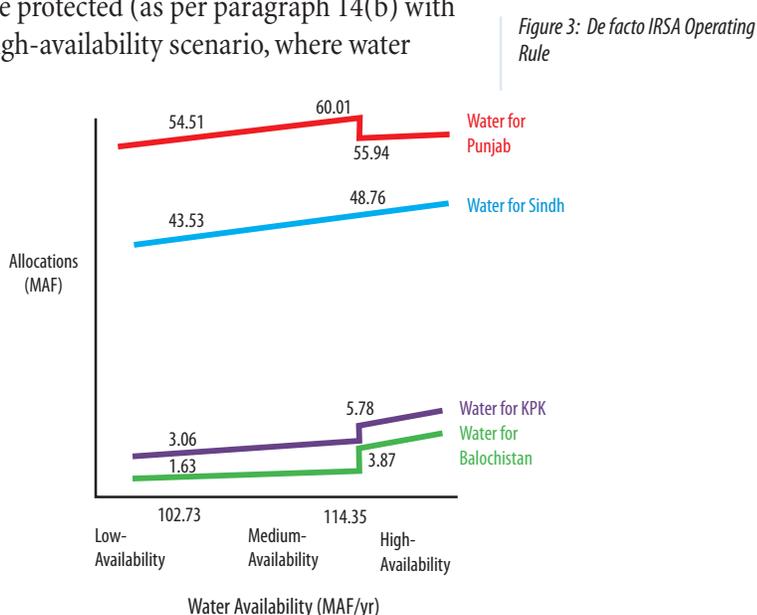
This achievement notwithstanding, there are important ambiguities in the 1991 Accord, especially relating to what constitutes “initial conditions” because allocations when there are shortages and surpluses are quite different. In the view of Punjab Province, paragraph 2 was contingent on the building of additional storage, and since additional storage has not been built, it is paragraph 14b that defines the starting point. In the view of Sindh Province, on the other hand, it is paragraph 2 that constitutes the initial conditions. IRSA officials have developed a modus operandi that works in practice, but it means that there are constant public disputes that exacerbate rather than reduces disagreements and mistrust. This contributes to a false public perception that the water accord “does not work”.

Governance of the Accord

The accord has been implemented for 20 years with a considerable degree of success. The members of IRSA have– not without ongoing disagreement– developed a formula for interpreting it that works though not without fueling mistrust. The formula is to provide water depending on the level of availability in the river system as shown in Figure 3. In the low-availability scenario, where water availability is less than actual average system uses 77-82, water is distributed as per paragraph 14 (b) of the accord. In the medium-availability scenario, where water availability is greater than the actual average system uses 77-82 but less than paragraph 2 of the accord, historic uses are protected (as per paragraph 14(b) with the balance distributed as per paragraph 2. In the high-availability scenario, where water availability is greater than paragraph 2 up to the limit defined therein, the allocations are as per paragraph 2, and any excesses are distributed as per paragraph 4 of the accord.

Financing IRSA

Since its inception, IRSA has had no financial independence and has been unable to finance its operations and staff. Recently, however, an important agreement has been reached that IRSA will receive earmarked budgets from levies on water delivered to the provinces and on energy generated. If these are made operational, this will provide a sustainable financial basis for IRSA.



Estimating water availability

The method for estimating water availability is outmoded and depends on correlations with prior irrigation season deliveries. IRSA sensibly adapts these estimates as the season goes; however, standard practice is that each province presents its own “estimates” which naturally accord with the interests of the specific province. This leads to systematic gaming by all and undermines trust in IRSA.

There are major, ongoing controversies over measuring flows at both the barrages and at the heads of the canals that distribute the water. These measurements are the responsibilities of the provinces. In principle, other provinces place officials to “check” these measurements, but this arrangement does not work. A decade ago a telemetric system was installed to automate the measurement and reporting process, but it has not worked.

There are similar serious controversies about the 20 MAF of water in the system that is “lost” in conveyance between the barrages and the canal headworks. This number has doubled over the last decade, although there have been no changes in flows or stream morphology. Prima facie evidence is that unauthorized abstractions are growing rapidly and are not accounted for. There is an urgent need for an independent, technical assessment of what these “losses” comprise, for defining what true conveyance losses are and for bringing illegal abstractions into the allocation and management system.

A positive development is that Punjab Province has taken several major steps forward. For the last 7 years it has been posting its measurements at the head of each canal (and down the canal) on line and updates the data every two weeks. It now also publishes the discharge measurements at the head of each canal and updates these on a daily basis. If other provinces were to do likewise, it would help a great deal. If the measurements made by each province were independently verified, a large source of mistrust would be eliminated.

Voluntary Re-assignment of Use

From the perspectives of equity, efficiency and conflict reduction, there is a strong case for introducing mechanisms to facilitate a voluntary re-assignment of water among users. Provinces could be better off if there were mechanisms whereby some entitlements could be temporarily transferred from one province to another. In some cases this is because provinces do not have the infrastructure needed to use their allocations, and have concerns that non-use may eventually lead to questions about its rights to that water. Their water is currently being used by others, and they would like to be compensated for this. In other cases such a voluntary transfer (in exchange for payment) would benefit both buyers and sellers and result in water moving from lower-value to higher-value uses. In other countries this mechanism has been vital in maximizing output, minimizing conflict and providing resilience in times of drought.

Discussions have shown that some provincial governments, such as Khyber Pakhtunkhwa (KP), would welcome the use of such a mechanism, while other provinces are opposed. Looking beyond the immediate political views, the WSTF believes that such mechanisms are central to the development of the flexible, voluntary arrangements which are needed in all arid environments. Visits to countries which make use of such mechanisms (such as Australia) and further analytic work and policy discussions are needed in Pakistan to improve understanding of this important tool and to develop consensus on the need for such tools in Pakistan. While the government and stakeholders consider these suggestions, the WSTF also believes that in the current environment

an important step is for the Government of Pakistan to make every effort to enable provinces such as KP to utilize water allotted to it under the Water Accord, such as through the construction of requisite irrigation infrastructure in the province.

Rewarding Provinces and Communities Affected by Hydropower Projects

Improving the implementation of the 1991 Water Accord is the first institutional measure to take to reduce conflict over much-needed major water infrastructure. The second measure is to re-frame the broad issue of “benefit sharing” specifically, to review the constitutional clause that states that profits from hydropower generation go to the province in which the power station is located. Short of reviewing the relevant constitutional clause, another option is for the Council of Common Interest (CCI) to develop the relevant policy on “benefit sharing” in line with international best practice for implementation by the provinces and federal government.

There is much confusion in Pakistan over the concept of “benefit sharing.” At one level, almost every Pakistani benefits from good projects that provide low-cost, reliable electricity, that augment the supply of irrigation water, and that protect people from floods. There is no need for any additional mechanism for sharing these significant benefits, but global experience has shown that special attention needs to be paid to those who “pay the price” by being resettled and losing their land. Good international practice provides benefits to those who are adversely affected by a project that produces national benefits. In Brazil, for example, 3% of total hydropower revenues are assigned to affected provinces, and 3% to affected municipalities, with shares of these amounts calculated on the basis of areas and numbers of people affected. Not only is such an assignment just, but it also gives affected provinces and people a stake in the projects and even a reason to welcome them. Shams-ul-Mulk, twice Chairman of WAPDA, has advocated changing the “profit sharing” formula in the constitution, and adopting a simpler and fairer system similar to the Brazilian approach.

Making Affected People the First Beneficiaries of Large Projects

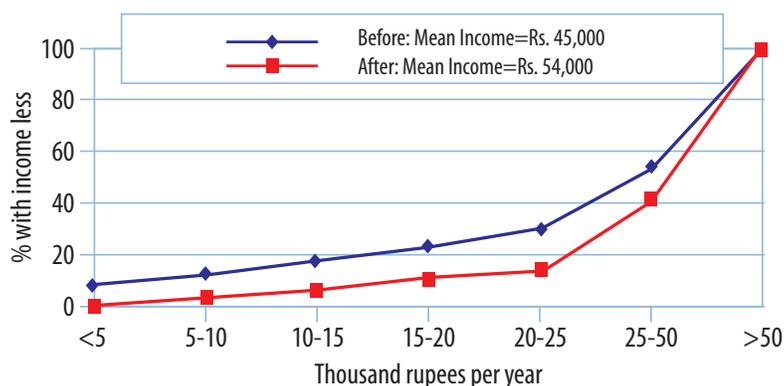
Of particular importance for the justice and politics of large dams are the ways in which local, adversely affected people are treated. This is related to, but not entirely coincident with payments from hydropower revenues described above.

In the case of Tarbela Dam, while there is an ongoing dispute on numbers, WAPDA considered that resettled people were dealt with by payments to the Revenue Department of KP; however, there was and is no mechanism by which these payments are passed on to affected people.

The result has been decades of hardship, lingering injustice, and a corrosive perception that local people will inevitably be collateral damage from such projects.

To its credit, WAPDA took a very different approach in the Ghazi Barotha project. A dedicated development agency (the Ghazi Barotha Taraqiati Idara) was set up, and the chairman was one of Pakistan’s great grass-roots development practitioners. The outcome (Figure 4) for affected people was very good; the Ghazi Barotha resettle-

Figure 4: Household income of families at Ghazi Barotha Hydropower Project before and after resettlement
Source: World Bank 2004



ment project became an example of global good practice. An excellent video by the Pakistani Network of Rural Support Projects– www.nrsp.org– provides a vivid presentation of the Ghazi Barotha experience and its potential application to the mega project at Basha.

Environmental Flows for the Delta

The 1991 Water Accord recognized that flows were needed to maintain the mangroves and fisheries of the delta and to limit saline intrusion. It indicated that the issue of these flows would be addressed once there was a conclusive study on what flows were required. This study was finally completed and reviewed by an independent panel of experts in 2005. It indicated that the delta required 5,000 cubic feet per second throughout the year (3.6 MAF) in regular flows “to check seawater intrusion, accommodate the needs for fisheries and environmental sustainability, and maintain the river channel” and a total of at least 25 MAF over 5 years in flood. The accord did not specify how these flows would be accommodated within the allocations. Would they come “off the top” (thus reducing allocations to all provinces) or would they come out of the allocations to Sindh, the province in which the delta is located? The accord also did not assign responsibility for delivering and monitoring these flows.

Resolving the environmental flows has been further aggravated by the ambiguity in the starting point of the accord described earlier, and it does not appear likely that in the near future the issue of allocation to the delta will receive greater attention than the other major issues with the accord.

What would appear to be feasible and appropriate would be for the accord to be revised so that once sufficient storage is built so that the “high level” (114 MAF) is assured, then the additional 3.6 MAF should be allocated off the top to the delta.

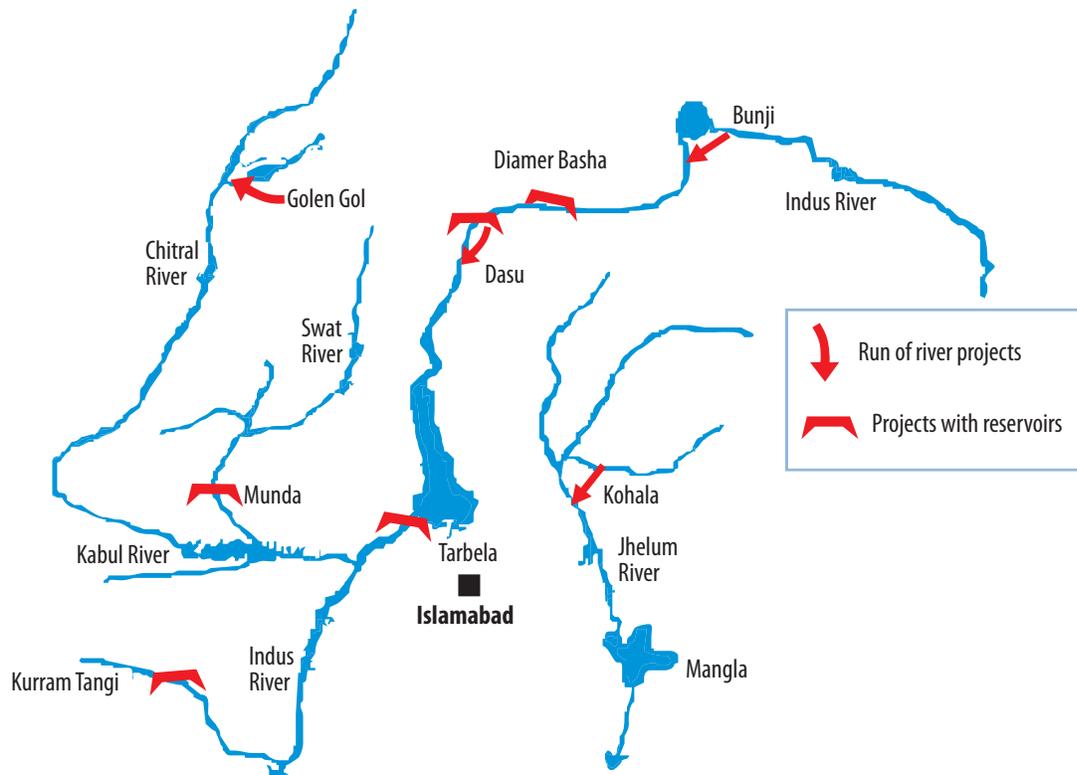
Priorities for Major Infrastructure

The Indus Basin system depends heavily on the functioning of existing major infrastructure. Maintenance and rehabilitation of the barrages loom high on this priority list. Extrapolating from the costs incurred in rehabilitating Taunsa barrage (about \$135 million) and assuming that three barrages will undergo major rehabilitation over the next five years, it is estimated that about \$400 million is required by the responsible provincial irrigation departments for this purpose.

Table 2: WAPDA’s Priority List for Major Dams in Coming Years

Project	River	Location	Capacity (MW)	Storage (MAF) Gross/Live	Est. Cost (\$ million)
Diamer-Basha	Indus	GB	4500	8,1/6,4	11178
Kurram Tangi	Kurram	FATA/KP	84	1,2/0,9	700
Golen Gol	Chitral	KP	106	RoR	130
Tarbela 4th Ext.	Indus	KP	1350		826
Munda	Swat	FATA/KP	740	1,3/0,7	1401
Kohala	Jhelum	AJK	1100	RoR	2400
Bunji	Indus	GB	7100	RoR	6838
Dasu	Indus	KP	4320	1,15/?	5206

Figure 5: WAPDA High-Priority Projects



As part of the Vision 2025 exercise, WAPDA identified a large number of major infrastructure projects. Working with the WSTF on a shorter time horizon, WAPDA has developed a list of 8 priority projects (Table 2 and Figure 5). Each project identified as a priority in Table 2 will add capacity to address critical issues of flood control, electricity generation, and added storage for irrigation. These priorities together form a portfolio that is balanced from all perspectives:

- **Irrigation:** To increase the assured yield of the system the most important objective is to increase storage on the largest river, i.e the main stem of the Indus. For this, Diamer Basha Dam (with live storage of 6.4 MAF) is key, with Dasu (live storage of about 1 MAF) playing a supporting role. But storage on the smaller rivers is also vital for local development. The WAPDA priority list includes Munda Dam on the Swat and Kurram Tangi on the Kurram, each of which will add about 1 MAF of vital storage capacity that will increase assured yield and thus enhance local development in the Federally Administered Tribal Areas (FATA) and KP.
- **Flood control:** Storage capacity is equally vital for flood control. Even though Tarbela Dam is operated primarily to meet irrigation demands, it helped considerably buffer the effect of the massive 2010 floods. The maximum flow into Tarbela Dam was 835,000 cusecs and released controlled flow downstream that went up to 604,000 cusecs, a reduction of about 30%. This saved the downstream river areas from even greater suffering. Basha and Dasu dams will add considerably to the capacity to control floods on the main stem of the Indus, but these projects will not help with floods coming from the vulnerable western tributaries. Munda and Kurram Tangi dams will be operated for flood control as well as irrigation and will have a major role in reducing flood damage in these flood-prone areas of KP and FATA.

- **Hydropower:** To increase the generation of clean, renewable, low-cost hydropower, the major opportunity is, again, on the main stem of the Indus. The multipurpose dams (Basha and Dasu) would respectively add 4500 megawatts (MW) and 4300 MW of capacity, and run-of-the-river Bunji would add 7,100 MW. The fourth extension at Tarbela would add a further 1,300 MW, and there are opportunities on other rivers, too. Munda, Kurram Tangi and the run-of-river Golden Gol Dam on the Chitral River will have a total installed capacity of about 900 MW, and the Kohala run-of-the-river project in Azad Jammu Kashmir (AJK) above Mangla Dam on the Jhelum River will add a further 1100 MW of capacity. Once this suite of projects is completed, this will increase installed hydropower capacity in Pakistan from 6,400 MW to about 26,000 MW.

Completing these projects will substantially increase the water productivity and security of Pakistan. The addition of about 10 MAF of storage capacity will mean that Pakistan has the capacity to store not 30 days but about 50 days of average flow. This will mean increasing the assured supply of water (for irrigation and growing cities) by about 10 MAF or 9% of current yield. It will also mean major reductions in the damages from many local and system-wide floods and that Pakistan's use of its 60,000 MW of hydropower potential will increase from 11% to about 45%. Current total installed power capacity in Pakistan is about 19,000 MW, with shortfalls in meeting demand of 5,000 MW in the summer. The additional 20,000 MW of installed hydropower capacity will contribute greatly to solving the endemic power problem.

The Economics and Financing of Major Infrastructure

The WSTF has estimated the economic benefits of investments in major infrastructure (Annex 1). The stream of costs and direct benefits yields a net present value of \$65 billion, and an internal rate of return of about 13%. Indirect benefits, which are expected to be at least as large as direct benefits, are not included in this calculation.

An important policy decision is determining the contributions of users to the financing of these projects. WSTF calculations in Annex 1 indicate that, excluding flood control benefits, about 65% of the benefits of Diamer Basha Dam are from hydropower and about 35% are from enhanced availability of irrigation water. This ratio is broadly consistent with the ratio 60/40 ratio that WAPDA uses to allocate costs for major multi-purpose projects.

To assess the financial viability of these multipurpose projects, the WSTF made an estimate of what users would have to pay in the hypothetical situation that all costs were passed on to electricity and irrigation users.

In the electricity sector there is an established regulatory structure for passing reasonable costs on to consumers. The four priority hydropower projects would require a tariff of about 4 Pakistan rupees (PRs) on the new power generated. For perspective, if the tariff charged on new hydropower were spread across all future electricity production (around 168 terawatt hours), it would raise costs by about PR 1, a small portion of the consumer charges recently announced by the National Electricity Power Regulatory Authority (NEPRA) of up to PRs 18.60 for peak period uses. Thus, with regard to hydropower, (a) users could pay their fair shares of project costs, and (b) there is a well-established regulatory framework and transmission chain for passing these costs on to users.

As in most countries with large irrigation systems, Pakistan treats irrigation as a quasi-public good and does not have a mechanism for users to bear their fair shares of the costs of new projects. This reality notwithstanding, the WSTF calculated that if all costs were to be borne by all irrigation users, this would mean a surcharge of \$25 per irrigated acre, an amount that is affordable compared with annual costs for pumping groundwater of between \$20 and \$80 per acre and gross margins of \$250 per acre for wheat.

After reviewing options and recognizing that these charges are far above what has successfully been received in abiana (user fees), it is likely that the federal government would assume this as part of overall federal debt (which it does for other investments in water, such as ADB- and World Bank- financed irrigation and barrage projects, and is common practice for water infrastructure projects worldwide). There are many shortcomings in this approach, but it is the only one likely to function. The WSTF estimates that new outputs would lead to direct and indirect revenues of about \$10.2 billion, so it would take only 5% of that value collected in general taxes to fully cover the additional costs assigned to irrigation.

A recurrent theme in this report is that while cost recovery in the electricity and water sectors is hugely important, it cannot be addressed by simply raising tariffs. The only politically feasible way of breaking out of the vicious cycle of “poor service/unwillingness to pay/worse service” into the virtuous cycle of “good service/high willingness to pay/better, financially sustainable service” is to (a) improve service, (b) find mechanisms for assuring suppliers adequate revenues through a combination of user charges and contributions from government and donors, and (c) inform users that tariffs will be gradually increased to make improved services financially sustainable.

In this context it is important that the wholesale and retail suppliers of electricity and irrigation and urban water services engage in a consistent, integrated, long-term communication effort that shows users how they are benefitting from these investments, and how tariffs will be gradually adjusted so that improved services can be sustained.

New Operating Rules

The original function of major infrastructure in the Indus Basin was to provide water for agriculture. The overwhelming challenge after the inception of Pakistan was to provide “replacement works” so that areas previously irrigated by the Ravi, Beas and Sutlej rivers could still function. Accordingly, the operating rules for the major reservoirs (Tarbela, Mangla, and Chasma) continue to be “to meet irrigation demands” with hydropower perceived as “a side benefit.” This continues to be the dominant philosophy. In the view of the WSTF, it is one that has to be reconsidered and is starting to be for several reasons. First, like all developing societies, Pakistan has changed, with agriculture providing a declining (but still very important) proportion of gross domestic product (GDP) and employment. Second, electricity has become as important a “basic need” for all people as water is for agriculture, and the economic and social costs of electricity shortages are hugely important. Third, as shown in the analysis of the planned, new major infrastructure, energy benefits are much larger than irrigation benefits (a reality that has been shown in a recent World Bank assessment of similar projects in Brazil, Egypt and India). Fourth, the last two summers have shown how important it is for Pakistan to develop a more effective, multi-pronged approach to flood management.

This is all well understood in Pakistan, and this multi-purpose view constitutes, as described above, the rationale for a balanced portfolio of major infrastructure that will be developed by WAPDA. What this puts into sharp relief is the need to review the simple operating rules (“irrigation first and the rest as a by-product”) that still pertain (and which some provinces believe should be permanent).

The WSTF developed a simple model to assess what the economic benefits of taking a multi-purpose approach to the operation of the post-Basha system might be. This model suggests that overall economic benefits could be as much as 20% higher if more sophisticated operating rules were adopted. An important policy decision, therefore, must be to authorize WAPDA and IRSA to develop operating rules that will maximize total social and economic value, and to communicate these changes to all involved.

It is important to note that not all provinces agree with this change in operating rules, despite the clear evidence of enhanced overall economic benefits, and despite globally acknowledged good practice. The WSTF acknowledges their concern that a change in operating rules could affect the availability of irrigation water especially during the winter planting season in light of insufficient storage in the country. The WSTF believes that as an initial step the Ministry of Water and Power should initiate a consultative process with key stakeholders to achieve consensus on the need for new operating rules as part of a package associated with the building of new dams and subsequent agreement on those rules as more water is made available through the new dams.

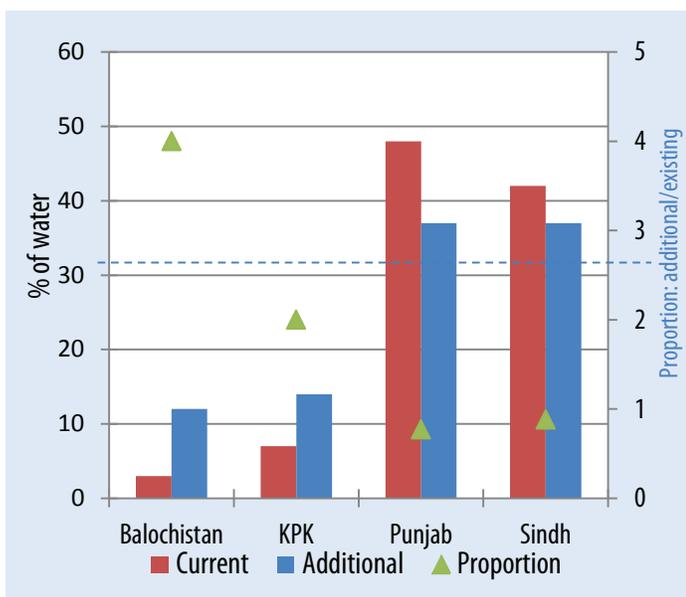
Moving Forward

For decades there has been a broad understanding that Pakistan needs to build new major water infrastructure, but for decades it has been impossible to get a consensus among the provinces on building the necessary infrastructure. The proposed Kalabagh Dam became a lightning rod for dividing provinces, and it was impossible to develop a consensus around its construction. In recent years, the federal government has wisely taken another approach and has put Diامر Basha Dam and the other projects listed in Table 2 on the front burner. With this change it has been possible to reach a consensus with an understanding that the greatest

relative beneficiaries from new storage, in order, are Balochistan, KP, Sindh, and Punjab (Figure 6). The CCI has now approved the construction of the highest priority Diامر Basha Dam.

The government and WAPDA understand that it is essential that fair and transparent means are found for ensuring that affected provinces and people become beneficiaries of large projects. While considerable progress has been made, it has been done in an ad hoc manner that is unlikely to be stable and unlikely to be acceptable to the international financiers on which such projects depend. Accordingly, as described earlier, it is important to enshrine both profit-sharing and resettlement practices into codes of practice that build on good Pakistani experience and the best of global good practices.

Figure 6: Who benefits from the new storage on Indus?



A leitmotif in the work of the WSTF was to describe not only technical possibilities but also political commitment. There is commitment to building Basha by all relevant political leaders including the President and Prime Minister and all chief ministers through the CCI and those with responsibility in key agencies including WAPDA and IRSA.

So the Government of Pakistan and WAPDA have done their part. But the reality is that Pakistan cannot finance these investments internally, so external development partners must assist. Financing such investments generally involves a mix of sources of financing. Export credit agencies will usually finance major parts of the technology-intensive turbines and other electrical and mechanical works. Bilateral partners can also make major contributions, both in terms of technical assistance and financing, but Diamer Basha Dam and Pakistan's other high-priority major infrastructure projects will not proceed unless there is support from the international financial institutions (IFIs), in particular, the ADB and the World Bank.

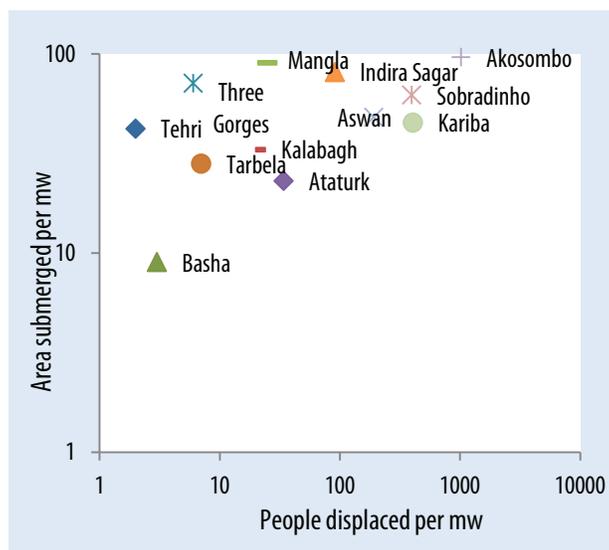
In recent decades these institutions have developed elaborate lists of "safeguards", with the World Bank list twice as long as the ADB list. The issues covered by these policies (including resettlement, environmental impact, cultural heritage, international waters, and disputed territories) are all important, and many are relevant for large projects. When they are good partners, the IFIs do due diligence on all of these issues, come to a balanced view of what the major ones are in a particular case, and make sure that the best does not become the enemy of the good. Too often international nongovernment organizations (NGOs) who oppose all such projects have been allowed to object "in series" with each step taking years, and uncertainty and project preparation stretching out over decades. This has stranded a large number of vital development projects and caused interminable delays and loss of benefits from those that do actually go forward.

In the case of Diamer Basha Dam, there are four issues of fundamental importance that must be given priority: agreement that the project will be implemented following standard international competitive bidding procedures; assurance that affected provinces will benefit from the project; adopting policies and practices for ensuring that resettled and other affected people become the first beneficiaries of the project; and implementing those policies and practices. The government and WAPDA are dealing well with all of these issues, but frequently in too ad hoc a manner.

Figure 7: Partial environmental and social indicators for some multipurpose dams

A host of other issues will be raised about Basha and will need to be addressed but do not appear to put the project in jeopardy.

- Environmental impacts are unlikely to be large (Figure 7 shows that both the area submerged and people displaced per MW are very low in comparison with other major projects). Good watershed practice is probably the key issue.
- Seismicity reasonably raises alarm but there are now well-established engineering designs for safe construction (witness the stability of recently-constructed dams in major earthquakes in Chile, Haiti, and Japan).
- International waters should not be an issue since the Indus Water Treaty gives Pakistan the right to develop the waters of the Indus.



Summary of Large Infrastructure Actions/Projects

The recommendations regarding major infrastructure are shown in Table 3.

Table 3: Action Plan for Major Infrastructure

No.	Action/Project	Objectives	Primary Responsibility	Timeline	Financing (\$ million)
1. MAJOR INFRASTRUCTURE AND ASSOCIATED INSTITUTIONS					
1.1	Rehabilitation of 3 major barrages	System sustainability	PIDs	2012-2016	\$400.0
1.2	Basha Dam in Gilgit Baltistan	Hydropower and irrigation	WAPDA	2011-2020	\$12,000
1.3	Kurram Tangi, Munda, Dasu, Kohala, Golen Gol, Bunji	Flood control and hydropower	WAPDA	2011 - 2020	\$14,000
1.4	IRSA Reforms	Increase transparency and predictability, and reduce conflict	IRSA	2012-2013	\$3
1.5	Revenue-sharing framework	Enhance equity and project acceptance	MOWP	2012-2013	\$1
1.6	Resettlement framework and capacity	Enhance equity and project acceptance	WAPDA	2012-2013	\$2
1.7	Environmental flows in the delta	Sustainability and equity	IRSA, Sindh Province	2012-2013	\$150

Source: WSTF calculations

Note: IRSA=Indus River System Authority, MOWP=Ministry of Water and Power, WAPDA=Water and Power Development Authority

There is strong commitment by the government and key agencies to addressing these issues. The WSTF recommendations are the following:

For the government:

- Re-double ongoing efforts to transform IRSA into an agency that can implement the 1991 accord with less political interference. This means strengthening its governance, securing its financial basis, and investing heavily in modern approaches to estimating water availability and to measuring and reporting water deliveries and losses. Twinning arrangements with river basin agencies in basins like the Murray Darling and Mississippi can help develop the human and knowledge resources of IRSA.
- Formulate a constitutional amendment so that mechanisms for providing direct benefits to affected provinces and people conform to global good practice and motivate affected

provinces and municipalities to welcome such projects.

- Transform the good practice developed for dealing with resettled people at Ghazi Barotha into codified standard operating procedures for all future projects. This will include substantially strengthening the capacity of the social and environmental arm of WAPDA. The objective should be to make local people into the first beneficiaries of any such projects.

For the development partners:

- Upon request, assist Pakistan in developing the knowledge base, human resource capacity and technology for managing the water accord. Particular emphasis should be given to twinning arrangements with successful entities in other federal countries, like the Mississippi River Commission and the Murray Darling Basin Authority.
- Insist that support for large infrastructure investments is coupled with support for improving the capacity for implementing the water accord and for adopting and implementing good environmental and social policies.
- Progress on this agenda is critical. Principled and pragmatic support from the FODP is vital and includes direct financial support and support on the boards of the ADB and World Bank for the highest-priority major infrastructure projects. Concerns of major import (including competitive bidding, equitable and transparent mechanisms for compensating affected provinces and communities) should be priorities and the host of other relevant issues (environmental impact, cultural heritage, international waters) should be dealt with pragmatically and should not jeopardize the projects.

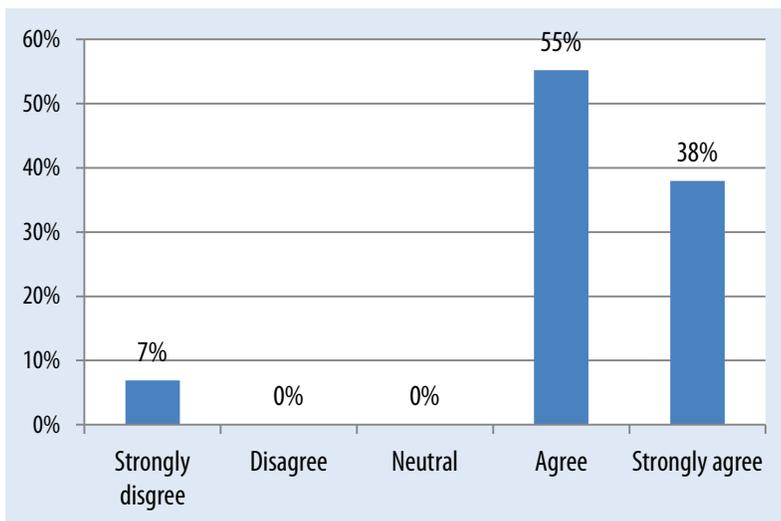


Figure 8: Stakeholders' assessment of the value of the diagnosis and recommendations of the WSTF Report: Major infrastructure

The December 2011 stakeholders' consultation discussed the diagnosis and recommendations on major infrastructure and associated institutions in considerable detail. The views of the stakeholders on this section of the report are shown in Figure 8.



INCREASING AGRICULTURAL PRODUCTIVITY

Diagnosis²

Agriculture in Pakistan simultaneously faces enormous challenges and great opportunities. The world's largest contiguous irrigation system was built in the 19th century. Constrained by the technologies of the time, it is a remarkable system based on the laws of gravity and the clock that also incorporated then state-of-the-art engineering, such as the design of “regime canals” that neither deposit silt nor scour their beds. As with all water resource systems, solutions are always provisional with new challenges arising as old ones are addressed. In the intervening 150 years the single greatest challenge arose as leaky canals filled the aquifer to the point where by the mid-20th century, large parts of the irrigated areas were suffering from the joint curse of waterlogging and salinity. Just in time there was innovation in two areas. First, there was innovative, applied research on groundwater which concluded that the solution was to increase the use of groundwater so as to leach salts, increase evapotranspiration and enhance agricultural production. Second, there was technical innovation in the form of the development and adoption of low-cost, submersible diesel-driven pump. For the most part the resulting groundwater revolution has been positive giving farmers control over their water supplies. Currently there are nearly 1 million private tube wells, 85% of which use diesel (and the rest electricity). At farm gate, the contribution of groundwater is more than half in the majority of the canal commands.

More than 90% of groundwater is being used for supplementing surface water supplies in canal-irrigated areas where it constitutes the largest source of water in more than half of the canal commands, in particular in Punjab. In spite of the fact that groundwater has greatly helped to meet the growing demand for food and fiber, in several areas in Punjab (especially the tails), intensive pumping has resulted in the gradual decline of groundwater levels, and the balance of surface water supplies, recharge, and groundwater pumping is in peril. Contrast this with Sindh – where canal irrigation duties and actual deliveries are higher and there is less incentive to use groundwater and where natural groundwater salinity is more extensive. Here the problem continues to be waterlogging, and here the application of less surface water and greater use of groundwater would be positive, as shown during the 1999–2003 drought when groundwater use increased and waterlogging declined. The broad conclusion is that greater attention should be paid everywhere to ‘conjunctive’ management of both surface and groundwater for both sustainability and productivity.

Throughout South Asia, the groundwater revolution has also meant that pressure on the canal system to perform has declined to the point where surface water infrastructure and institu-

2. For more details, see Annex 2 on agricultural productivity.

tions have been allowed to degrade. Today the situation is a vicious downward cycle: the quality of service is poor; some areas continue to be supplied with too much water and suffer from waterlogging and salinity; other areas have too little water; the canal systems are not financially viable and “investments” are not for constructing new capacity but for trying to make up for non-existent maintenance (the so-called “build/neglect/rebuild” cycle).

The net result of the groundwater revolution and the decay of the surface systems have been mixed at best. The most important measure of all— the productivity of agriculture measured in terms of total productivity or productivity per unit of water, land, and other input— remains low by global and even regional standards. Figure 9 shows how low cereal yields are per unit of water and land compared to those in India and the USA. There are many reasons for this poor performance; with poor water management being a major one.

It is now apparent that this strategy of benign neglect has to change. The safety valve of expanded use of groundwater in arid areas and the canal commands of Punjab is no longer viable as the quantity, depth, and quality of groundwater, the costs of diesel, and the unreliability of electricity have all become major impediments to further developing the resource that has saved Pakistani agriculture. The increased use of groundwater is tapering off in the canal commands. In some of the arid zones of the country, in particular in Balochistan, alluvial aquifers have been exhausted and groundwater use in some critical aquifers is a fraction of what it used to be. At the same time, there is much to gain by pro-actively addressing water logging in Sindh and achieving a better balance between surface water deliveries and groundwater use— while freeing water for productive use elsewhere.

Pakistan is now at a critical juncture. On the one hand, the track record of reform efforts, including the so-called National Drainage Program (NDP)/SIDA/PIDA reforms, is mixed and there is understandable reluctance to tinker in ways that could make things worse. On the other hand it is clear that continuing with business as usual will cause massive problems for economic growth, for poverty reduction, and for environmental sustainability. These issues were discussed extensively in the course of the WSTF work. A broad, but not unanimous consensus was that there have to be reforms, that reforms are complex

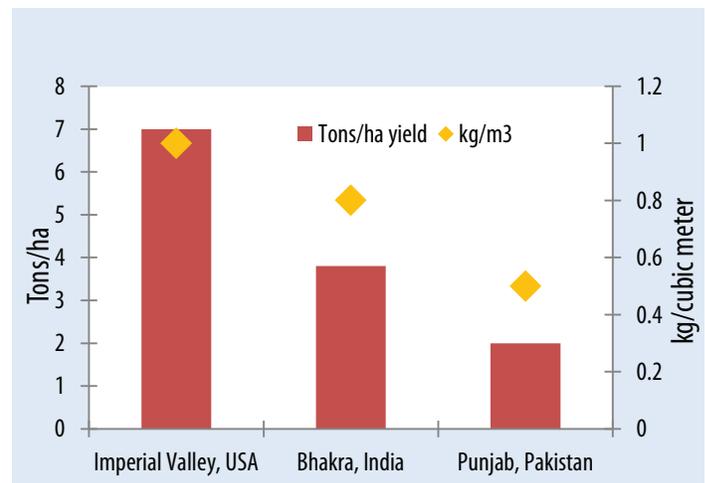
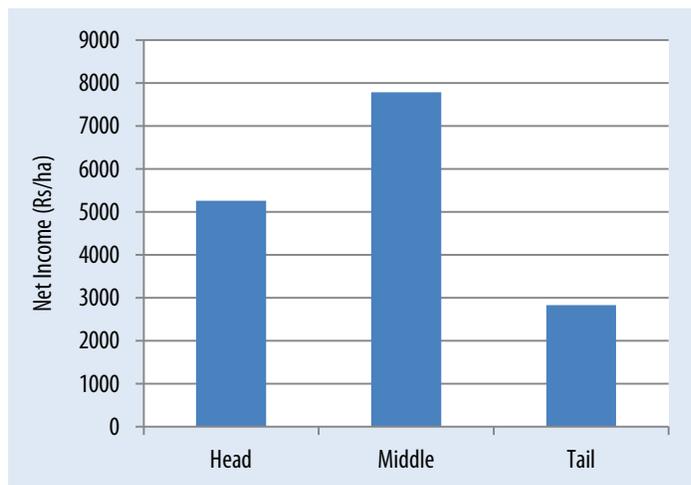


Figure 9: Wheat yields per unit of land and water. Source: Ahmad 2005



and must be done with the participation of all stakeholders, and must proceed by doing pilots, evaluating them and then scaling up successful approaches. The outline of some promising reform directions emerged from the extensive engagement of the WSTF with farmers, bureaucrats, the private sector and some political leaders.

Some hints of the promise of reforms are evident disparities in the application of water across canal commands and within distributaries. Figure 10 shows that output is suppressed by too much water at the head of many

Figure 10: Low productivity from too little and too much water. Source: Bhatia 2005

canals as much as by too little water at the tail ends. There are also enormous disparities between average production and production by progressive farmers who for the most part operate in enclaves in which they are not prisoners of outdated technology and unaccountable institutions. As shown in Table 4, the differences are large, and pose the central question of how the performance of ordinary farmers can be raised to levels approximating those of high-producing farmers.

Table 4: Yield Gap for Major Crops in Pakistan (tons/ha)

Crop	Progressive Farmers	National Average	Yield Difference (%)
Wheat	4.6	2.6	44
Cotton	2.6	1.8	31
Rice	3.8	2.1	45
Maize	6.9	2.9	58
Sugarcane			
Punjab	200	55	73
Sindh	130	50	62

Source: Task Force on Food Security (Sartaj Aziz, 2009). Final Report of the Task Force on Food Security, Planning Commission, Government of Pakistan, February 2009.

The Okara Potato and Vegetable Growers' Association is one of many examples of such high-performance enclaves that have been established in recent years. The association imports potato seed from Switzerland, multiplies it in Gilgit-Baltistan, and then distributes the seeds to its members in the plains. Hundreds of the association members have cold chains for potato, fruits and vegetables. Their productivity is the highest of all potato producers in the country, and their productivity of spring maize is 9 to 12 tons per hectare (compared to the national average of just 3 tons per hectare).

The WSTF included experts with Pakistani and global experience. They identified other relevant irrigation reform processes in other countries and incorporated lessons from these experiences into the workshops and meetings. Two experiences emerged that appear to be particularly relevant for Pakistan.

The first is the experience of Egypt which has used innovations in both greenfield areas and in the Nile Delta to develop public-private partnerships for high-efficiency, high-technology methods for developing high value-added agriculture. The productivity of fruits and vegetables in Egypt is significantly higher than the current productivity in Pakistan, and wheat, sugarcane, and cotton yields are twice those in Pakistan.

The other example is Brazil which has become an agricultural superpower by harnessing the power of science and innovation. Only about 10% of the four-fold increase in agricultural output over the past 30 years has come from increased inputs of land, labor, and capital. The remaining 90% is attributable to “total factor productivity”, a technical term which means getting more output out of the same inputs. To cite just one example, sugar-cane yields in Brazil are three times those in Pakistan. A particularly relevant current Brazilian innovation is the replacement of old-style publicly managed irrigation systems with new forms in which private operators are awarded concessions for developing and managing command areas. The concessions are awarded competitively with bids evaluated according to the amount of public investment required and the quality of the business plan with respect to engaging small farmers in the command areas.

Priority Actions, Time Frames, Costs and Expected Outcomes

The central effort of the WSTF in this domain was to engage in workshops, meetings and field visits with farmers, bureaucrats, the private sector, and political leaders to articulate the first steps of an action plan to start moving Pakistani agriculture forward.

As agreed with the steering committee, the WSTF not only assessed priorities from the perspective of technical criteria but also gave high weight to responding to political leaders who showed commitment and asked for WSTF engagement.

The outstanding example of this in the area of agricultural productivity was in Punjab. The government of Punjab has articulated a vision of Punjab as a regional agricultural powerhouse and has engaged other political leaders, the private sector, and the bureaucracy to identify what needs to be done to realize this vision. The provincial government saw the WSTF as an opportunity to push this agenda forward. One important outcome was a consultative workshop co-hosted by the Government of Punjab and the WSTF in Lahore in July 2011. It started with presentations from a variety of progressive farmers and companies active in agriculture. The focus was on what they had managed to achieve, what constraints they faced, what was stopping average farmers from increasing productivity, and what the government needed to do. There were also presentations from farmer organizations giving their perspectives on constraints and challenges. Finally the Government of Punjab described how it perceived the challenge, and how it intended to move forward to turn its vision into reality.

While the discussion was specifically about Punjab, the set of actions that emerged from the Lahore workshop (Figures 11, 12 and 13) provided a template for discussions with other provinces and the special areas. The recommended actions are the following.

Continue Investing in Improved On-Farm Water Management

The provincial directorates of on-farm water management (OFWM) have sought to improve water management on the farm, and have been successful at it. Their programs have promoted precision land leveling, watercourse lining to reduce seepage losses, and more efficient ways to apply water to the land than flood irrigation. Many of these services are now provided through the private sector. The 6-year National Program for Improvement of Water Courses was launched in 2004. The provinces of Balochistan and KP completed all targeted watercourses (Balochistan 13,466 and KP 10,000) by 2008, well ahead of schedule. The provinces of Punjab and Sindh achieved 60% completion by 2008 and 100% completion by 2010.

Another program with great potential is water use and tillage technologies that promote the use of zero-tillage technology, the bed and furrow method of water application, and the use of crop residue as mulch to conserve soil-moisture.

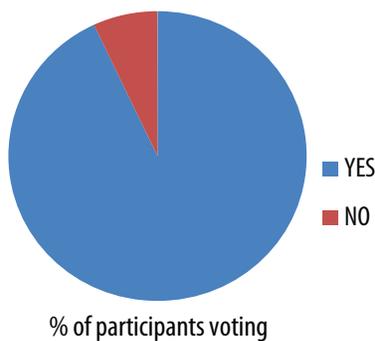
As shown in Figure 11, there was almost unanimous support at the Lahore workshop for intensifying investments in OFWM. There is also strong political will for such projects throughout the country with many members of parliament sponsoring schemes from their development funds.

Strong as this support is, the WSTF recommends that the next round of OFWM investments should go one step further in terms of institutional arrangements. This OFWM+ approach recognizes that public-private partnerships will be most effective in implementing this next generation of integrated OFWM interventions. The steps to implement the approach are the following.

- Select distributaries one each at the head, middle, and tail of a selected canal in consultation with the provincial irrigation and drainage authorities and farmers' organizations.
- Develop requests for proposals (RFPs) for registering private sector service providers to provide integrated services and supplies to farmers. (A draft has already been developed by the Ministry of National Food Security and Research and can be adopted by the provincial governments).
- Suggest cropping patterns based on comparative advantage and farmers' preferences, balanced inputs, and best practices on the farm.
- Assess the impact of the availability and application of water on the farm (Nacca command), on increasing cropping intensity, on reducing labor, and enhancing water productivity.
- Build awareness of farmers and train them and water-user associations (WUAs) in methods for improving water productivity.
- Scale-up activities on the farms, watercourses, distributaries, and the whole of the canal command.
- After identifying successful infrastructure and institutional arrangements, extend them to other canal commands.

Figure 11: Agriculture Productivity Action Proposal #1

In all irrigated areas: Do you recommend that Govt of Punjab give high priority to ongoing OFW efforts (laser leveling, selective lining of water courses, pressurized irrigation)?



One year is required to develop the methodology and pilot-scale testing for the integrated implementation of OFWM initiatives at the water-course command; a total of 5 years is required to cover the pilot and extension to other canal commands.

Discussions with the WSTF showed that provincial governments, the WUAs, and the farmers are all willing to contribute to funding the costs of such projects. The farmers' shares in cash are expected to be in the range of 10% to 50% depending on the type of intervention with an average of 30%. The provinces have been contributing 20% to past projects which can be increased to 30% considering the devolution of the agriculture sector and the higher priority they have assigned to water productivity. To make such a program work, external finance would contribute 40% of project costs covering part of the investment cost and the full-cost of technical assistance, training and building institutional arrangements and mechanisms. Particular emphasis should be placed

on the software which is often neglected in federally-funded projects and is essential to implement current OFWM initiatives in an integrated, prioritized and sequenced manner.

The estimated cost of the program for Punjab is \$300 million, for Sindh is \$100 million, and for KP and Balochistan \$50 million each. In addition \$20 million would be needed for FATA, Gilgit Baltistan and AJK. Thus the estimated total cost of the proposed program is \$ 560 million with an external donor share of \$224 million. The provincial governments and farmers will share \$168 million each.

Establish New Public-Private Partnerships to Stimulate High-Performance Agriculture in Areas Irrigated by New Medium Dams and Spate Irrigation

In all provinces and special areas, there is considerable potential for developing irrigation in areas outside of the main Indus Basin Irrigation System (IBIS) by constructing small and medium-sized dams and their command areas, and through effectively using sporadic floods through spate irrigation systems. In this area there is good news and bad news.

The bad news is that many recent projects in these areas have performed poorly. The command area developed in most small and medium-sized dams is only 50% of the designed command area, largely due to the faulty and un-imaginative design of the canal and to the poor construction by farmers of watercourses in the undulating terrain. Basic services like precision land leveling, a pre-requisite for surface irrigation, are often not available. Water conveyance losses in the main canal are as high of 50% largely due to poor-quality lining. The reservoirs are silting up as watershed management was never part of small dams' projects. Innovative designs, such as cascade check dams on the main tributary or off-stream reservoirs are not considered in spite of their proven success in other countries with similar semi-arid and arid conditions.

The good news is that it is entirely feasible to reverse this trend and make these areas highly productive; in fact, a presidential directive states that high-efficiency irrigation and high-equilibrium farming systems should be introduced with all these new dams. There is also considerable scope to balance surface supply with groundwater use in the commands of the dams. The Pakistan Agricultural Research Council (PARC) has been an innovative participant in these areas and has been directed to play a major role in the design of such systems and in ensuring that they are integrated projects whose impact will be measured in terms of the value of production and not simply the tons of concrete, kilometers of canals, or cubic meters of water delivered. This is an area where the private sector can play a major and integrating role - including financing dam construction and the conveyance and delivery of water to users. Water can be delivered to the farms via pipes where it is used more efficiently through drip and sprinkler irrigation. Unlike the IBIS, private developers could control the free rider problem and get properly paid for their services. The provincial irrigation department (PID) could tender concessions to the private sector to develop and manage such irrigation schemes. As shown in Figure 12, in the Lahore workshop there was strong support

Figure 12: Agriculture Productivity Action Proposal #2

New irrigation commands Do you recommend that Govt of Punjab bid concessions (to private operators) for new systems with requirement for inclusion of small farmers in value chains?

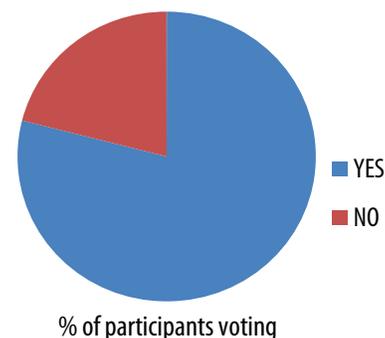
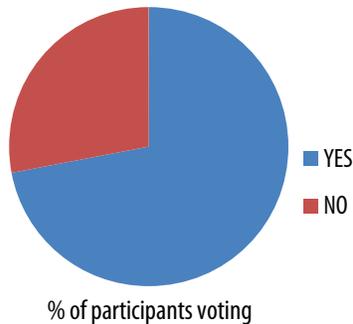


Figure 13: Agriculture Productivity Action Proposal #3

Improving management of the main canals: Do you recommend that Govt of Punjab contract one or more of the Canal Commands (starting from Barrage to Tail-end distributary) to private operators to deliver entitlements reliably and transparently?



for a major role for the private sector in building and operating small-dam irrigation commands. In follow-up consultations with the WSTF, all provincial governments and private sector representatives identified medium-sized and small dam development as an appropriate area for the private sector.

This broad consensus bodes well for the future of this model in Pakistan. The stakes are high, both because of the wealth and welfare that can be generated in these specific projects, but also because success will (as happened in Egypt) put pressure on the “old system” to reform and start producing like the “new areas” are producing. The provincial government must, however, walk a fine line. On the one hand there is a need for action and for results, and there are private operators ready to go. On the other hand, there is a long history in many countries of great initial hopes for PPPs that were dashed because of insufficient preparation and consultation.

The WSTF therefore recommends that provincial governments that want to move in this direction (i) pay attention to the lessons of experience and make sure that they have the public architecture and contractual structures right, (ii) do so with a sense of urgency and impatience to achieve results, but (iii) that they not cut corners because short-cuts will prove to be long-cuts! Any public-private partnership must recognize the different roles played by government, shareholders, and users and develop a practical and balanced regulatory framework (Figure 13). It is important, too, to understand that there is a wide range of depths of private sector involvement (and corresponding public sector involvement) as shown in Figure 14 from simple service contracts, to management contracts, to leases, to concessions, and to full privatization. Smart institutional design must understand the risks for each party and assign these risks to those most able to bear them. In addition, the design must be dynamic with ever-deeper forms of private sector involvement as the process matures.

The WSTF therefore recommends that committed provincial governments follow the process outlined below for developing public-private partnerships to build small and medium-sized dams and to develop the commands of existing and new dams.

- The provincial government with the Chief Minister playing a prominent role will manage the process.
- Secure technical assistance from a development partner with extensive experience with private sector participation in infrastructure (such as the Water Resources Management Group, which involves the International Finance Corporation [IFC] and the ADB) to:

- review the lessons of experience with contractual forms in other countries, paying particular attention to ways in which the contracts dealt not just with water services but also

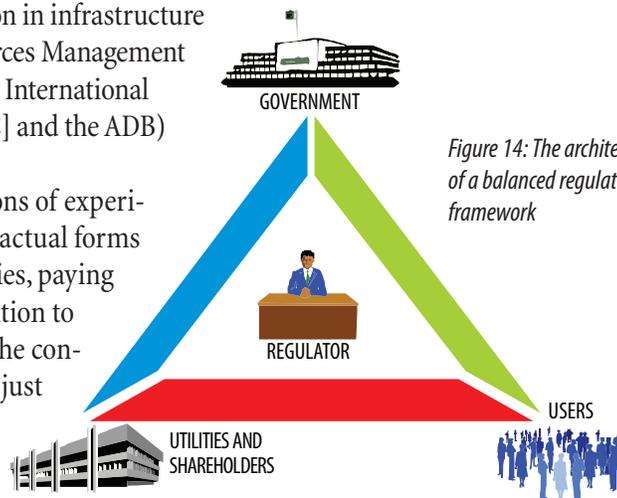


Figure 14: The architecture of a balanced regulatory framework

with providing complementary credit, seeds, technology, agronomics, marketing, and watershed management inputs;

- arrange visits for political leaders, government officials, local private sector operators and farmers to successful projects;
- develop a process for private sector participation that includes defining options for public-private partnerships and defining appropriate legal and regulatory structures.

It is imperative that this process be transparent and encourage participation by a wide range of stakeholders, including the government, the private sector, farmers and civil society; and

- present options for different forms of public-private partnership (Figure 15) for the government to consider.
- Obtain technical and financial support from one or more capable development partners to establish the institutions necessary for managing this process and for financing start-up costs which are likely to include public financial contributions to the PPPs and for developing capacity in farmers' organizations.
- Decide on the areas where the initial contracts are to be issued giving priority to areas where the probability of success is relatively high.
- Monitor, evaluate, and adjust both the initial contracts and the overall program.

The situation with regard to spate irrigation is similar to that for small and medium-sized dams. There is considerable potential for development of spate irrigation by diverting water from short duration flash floods to irrigate land and to fill water ponds, range and forest lands, and to recharge shallow aquifers. The productivity of spate irrigation systems in Pakistan is significantly less (50%) than in other countries with large spate irrigation areas. PARC has estimated that the potential area which could be developed with spate irrigation is 2 million hectares including the existing 0.6 million hectares watered in an average year. The largest potential is in Balochistan, but there is considerable scope in the other provinces too. Other promising areas are in DI Khan and DG Khan. There is strong political support for these projects with members of parliament from Balochistan, KP and south-western Punjab regularly contributing to spate irrigation schemes from their development funds.

Managing spate irrigation would be similar to managing small and medium-sized dams and would include the following.

- Selection of spate irrigation schemes for integrated development and management with the active participation of communities, and contract management functions outsourced to private sector service providers/operators for an initial period of 10 years.
- Develop RFPs to select private service providers to take manage the schemes and regulate the water including specific responsibilities for the provincial government (including the power to settle conflicts), existing institutions, farmers' organizations, individual farmers, and private operators/service providers.

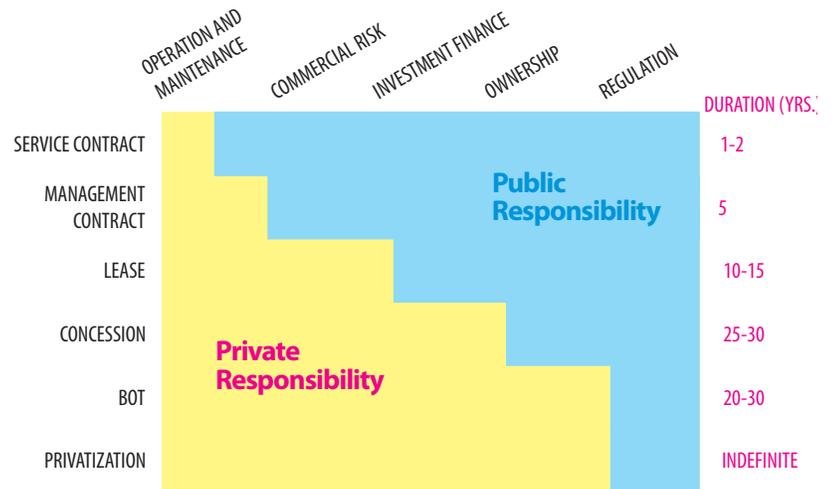


Figure 15: Options and characteristics of public-private partnerships

- Organize existing communities through social mobilization and institutional development.
- Develop institutional mechanisms for the long-term management of spate irrigation, watersheds, and command areas in terms of services and routine operations and maintenance (O&M). This requires on a priority basis (i) the restocking of earth moving equipment (bulldozers, frontloaders) essential for constructing the earthen diversions and guide bunds, and (ii) working out the private sector institutional mechanisms for continued service delivery.
- Develop and implement an equitable water distribution system based on historic water rights to reduce conflicts with new projects.
- Invest in new infrastructure suitable for spate irrigation diversion (bed stabilizers, permeable spillways, reinforced embankments, recharge weirs) to secure the system - and to develop the other functions of spate irrigation – such as stock-water ponds for livestock.

One year is required to develop the methodology and pilot-scale testing for the innovative management of commands of small and medium-sized dams and spate irrigation systems by private operators and service providers, farmers' organizations, and farmers. A total of 5 years is required to cover the whole command and to build the capacity of the staff of private operators, farmers' organizations, and WUAs. Linking farmers' organizations and WUAs with private-sector service providers will help to build forward and backward linkages for the provision of inputs and marketable products.

The actual cost per scheme will vary in each province based on the size of the command area and the availability of water. The estimated average cost for a small/medium-sized dam project is \$20 million for integrated development and management. The average cost of constructing, developing, and managing a spate irrigation scheme is also estimated at \$20 million for a scheme including the construction of critical infrastructure. In all, 23 (5 each in Punjab, KP and Balochistan; 2 each in Sindh, AJK, Gilgit Baltistan and FATA) small/medium-sized dams are suggested for a total cost of \$460 million with an external donor share of \$276 million (60%). The provincial governments will share \$138 million (30%), and farmers will contribute \$46 million (10% of project cost or 30% of productivity enhancement interventions).

In addition, three spate irrigation schemes are recommended for KP, for Punjab, for Sindh, for Balochistan and for FATA for a total of 15 spate irrigation schemes at a total cost of \$300 million with an external donor share of \$180 million (60%). The provincial governments will share \$90 million (30%) and farmers will contribute \$30 million (10% of project cost or 30% of productivity enhancement interventions).

Promote Innovations in the Management of the Main and Branch Canals

Over the last 15 years, a series of reforms (known as “the NDP reforms”) has aimed to improve the quality of water delivery services in the IBIS. Some reforms have worked well and some have not, in part because of shortcomings in conceptualizing networked services.

Networked services can be provided through a combination of formal and informal institutional arrangements. As shown by the pioneering work of Akhter Hameed Khan in Pakistan, whether a formal or informal arrangement works best on any particular part of the network depends on technical complexity and transactions costs. At one extreme it is obvious that a user's group cannot manage the construction and management of a barrage as this requires

a formal organization with high levels of engineering capability. At the other extreme, on a watercourse the most challenging aspect is not technical but cooperative management by users. At this end of the spectrum farmers' organizations are more effective than government organizations. The NDP reforms correctly identified farmers' organizations/WUAs as key at the bottom end of the spectrum. For the most part they have worked fairly well, and there is broad concurrence that this part of the reform model should be maintained. The major problem conveyed to the WSTF during the course of its field visits, consultations with farmers' organizations and the Lahore workshop was the lack of predictability and accountability in the next level up the network. Where the task is managing branch and main canals, the NDP model required "an organization of farmers' organizations, namely the area water board (AWB)" to manage the canals. This has not worked well, and it now is clear that this is a step too far for an informal organization.

A key question then is what form of formal organization is appropriate to manage the main and branch canals. The irrigation departments (and their close cousins the PIDA and SIDA) did not and do not do this well, and it has proved beyond the capability of the farmer-based AWBs. Consultations with farmers' organizations and the Lahore Workshop highlighted this issue and gave rise to discussions about "a third way" (neither the AWBs nor the Irrigation Department) at this critical level. It was concluded that it is worth trying a new arrangement at this level – a performance contract to a private canal operator and service provider who would be given a contract with performance incentives to deliver water according to entitlements in an effective predictable way to the farmers' organizations.

In such a re-engineered system, the distribution system (Figure 16) would be unbundled into three entities. The irrigation department would, as now, operate the barrages. Private operators with specific performance contracts would invest in the necessary infrastructure (which

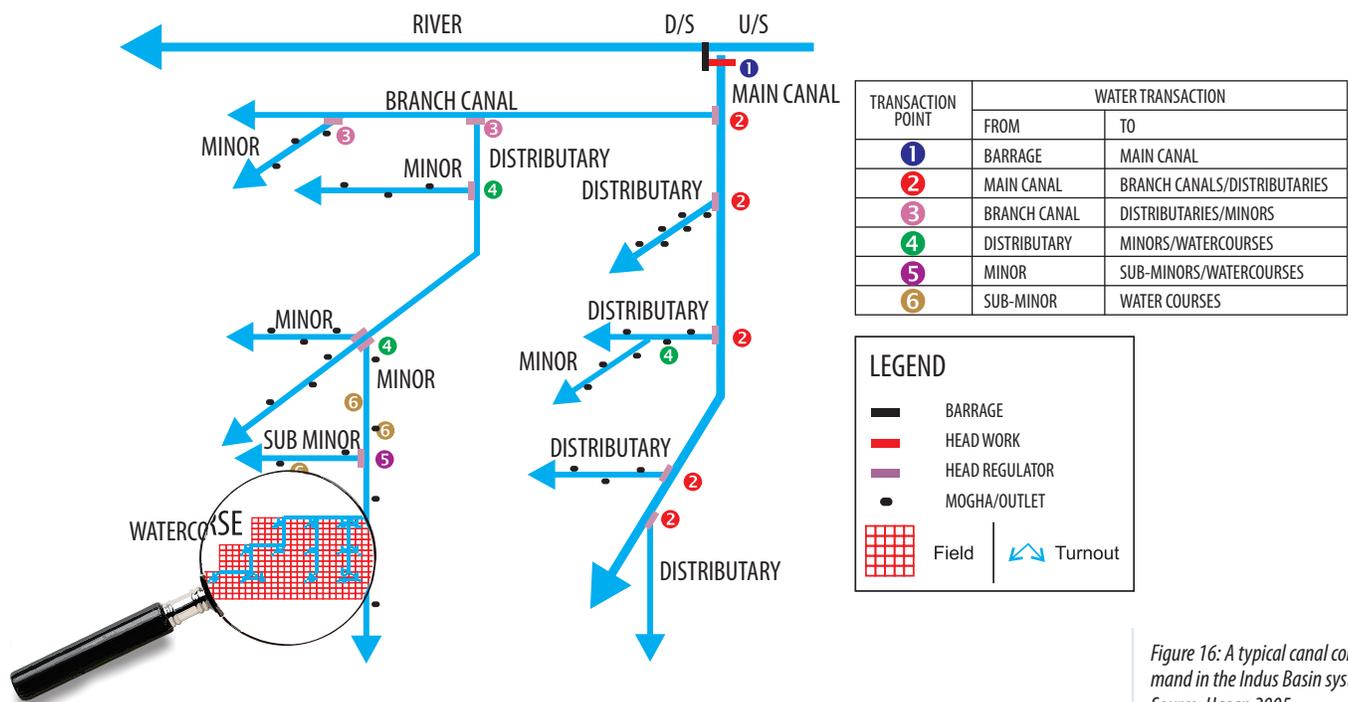


Figure 16: A typical canal command in the Indus Basin system. Source: Hasan 2005

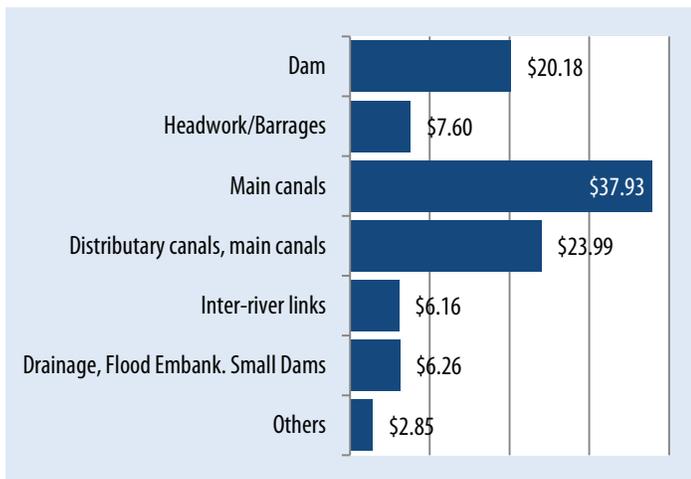


Figure 17: Annual costs of operation and maintenance of the irrigation system in \$/ha

would include on- and off-canal storage and control structures) and would operate the main and branch canals. Farmers' organizations would operate the distributaries and WUAs the watercourses. What is essential is that the entitlements at each level are clearly established, that there are measurement structures at each interface, and that there is trusted, transparent measurement and reporting of entitlements and deliveries. The on-line system in Punjab, which has been in place for 7 years, is a major advance and needs to be universally applied throughout the IBIS. This also affords an opportunity to discuss with the farmers' organizations how their surface water allocations could be tailored to

match the potential for groundwater pumping in different areas. This will help remove the last areas suffering from water logging in Punjab and help correct imbalances in other areas that rely too heavily now on groundwater pumping. In Sindh, the issue is larger, and water logging remains widespread. Within the boundaries of what is possible with enlightened and transparent politics, surface water allocations to different parts of the canal command should be revisited to stimulate more use of shallow groundwater, particularly in areas with relatively good quality groundwater, and at the same time explore the scope for expanding the canal area elsewhere.

How much might such a service cost and how would a private operator be paid? Using the current institutional arrangements to operate and maintain the current irrigation system, an asset management planning exercise done by the Government of Punjab showed the breakdown of costs from the dams to the watercourse (Figure 17). The overall O&M was about \$100 per hectare, with roughly 20% of the costs attributable to dams, 8% to barrages and headworks, about 43% to main canals and link canals, and 25% to distributaries and minors. It is likely that this cost is both too low (because it does not include the costs of rehabilitating assets) and too high (because the irrigation department is not an efficient supplier of services). Would users be willing to pay \$40 per hectare per year (or PRs1400 per acre per year) for a high-quality water service?

It is important to note that there is a de facto market test of willingness to pay for a high-quality service since farmers do pay for pumping groundwater. As shown in Table 5, farmers are willing to pay from PRs1400 to PRs8000 a year to irrigate 1 acre. This suggests that farmers could and would (if the incentive structure for both the service provider and farmers was right) be willing and able to pay the cost of PRs1400 per acre a year for a reliable water service. It should also be noted that such payments could by no means be taken for granted. Current abiana rates are of the order of PRs135 per acre per year, or 1% to 4% of the value of a good

supply of water, and still collection rates are very low.

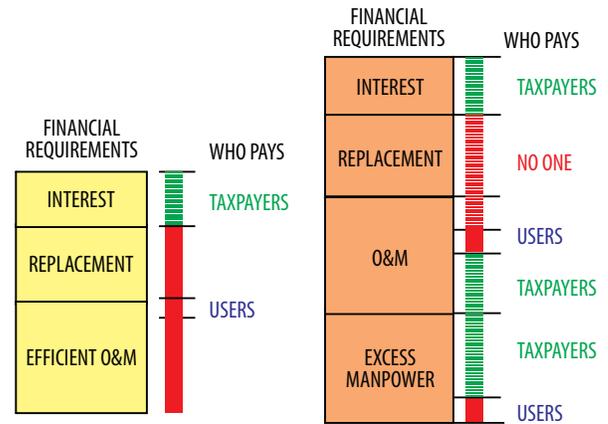
Table 5: What farmers pay to operate tubewells for irrigation water in the Punjab (Rs/ha, Year 2009)

Zone	Wheat	Rice	Cotton
Rice-wheat (Gujranwala)	5000	20000	
Rice-wheat-cotton (Faisalabad)	3300	18000	
Cotton-wheat (Khanewal)	5100	18000	10300

Source: Project Management and Policy Implementation Unit, Ministry of Water and Power (2010). Policy Studies for Enhancing Land and Water Productivities through the Use of Resource Conservation Technologies, Islamabad, March 2010.

It is important to re-state the WSTF philosophy of cost recovery. The WSTF is aware of the importance of moving from the unsustainable current financing model to a sustainable and accountable model (as illustrated in Figure 18) and firmly believes that cost recovery

is both very important and cannot be the leading edge of an irrigation reform process. The sequence out of the vicious cycle (poor service/low willingness to pay/worse service) to the virtuous cycle (good service/payment for service/maintenance of good service) must start with good service and then, once credibility is established, move gradually to have users pay for the costs of that service. The aim should be to have all users repeat what a farmer in an improved system in Andhra Pradesh once said, “We will never allow the government to provide us with a free service again!”



Accordingly, the canal operator would initially be paid by an external source (the government or a donor) so that there are sufficient resources to improve the system and to operate it effectively and transparently. An important element of the relationship between the private operator and the farmers’ organizations would be to make it clear that as service improved, the organizations would pay the operator according to an agreed schedule over a specified time period. This transition, which has been effective in other settings, is shown schematically in Figure 19.

Figure 18: Financing for the vicious and virtuous cycle irrigation models.

It is well understood that contracting a private operator would be an experiment that would take all parties – the government, the private sector and farmers – into uncharted waters. Accordingly it is recommended that such a program be very carefully designed by professionals who have extensive experience with such public-private partnerships. In the case of Brazil, the government hired the IFC as an investment advisor for a similar process. The terms of reference for the advisor would be to design the legal, regulatory, and operational elements of the contract. Factors that would need to be taken into account in the design include the following:



- the political will at high levels (the chief minister) to lead such a transformative approach;
- the experience with similar efforts in irrigation and other services around the world;
- selecting a canal where there are pre-conditions (enlightened farmers, good logistics, and well-established agricultural support services) for rapid growth in high-value agriculture;
- the appetite of the local private sector to engage in such a contract (global experience shows that successful efforts are led by local firms with international companies often playing important roles as part of a consortium but not the lead);
- the appetite of farmers’ organizations to work with such a bulk supplier;
- assessing the political, natural, and commercial risks of such an arrangement and designing a structure that assigns risks to the parties that can most appropriately bear them;
- developing a contractual form that would meet the objectives of the various parties;
- designing a regulatory structure that would be responsible for monitoring the contract and making the adjustments that are always necessary in a new arrangement; and

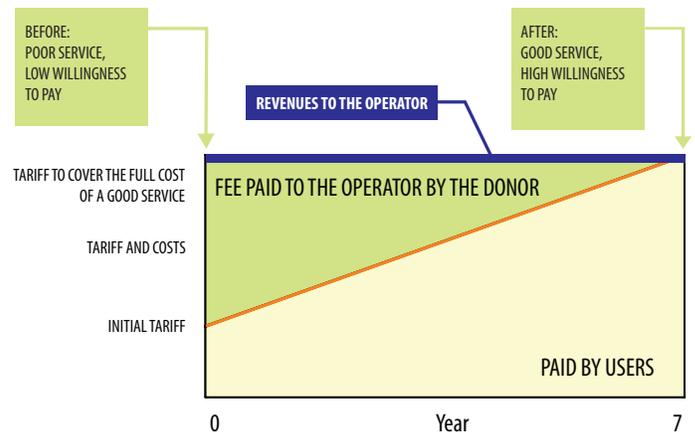


Figure 19: Transition from low-level to high-level equilibrium.

- engaging with donors to ensure financing of the arrangement during the critical period of about 5 years when revenues from users will not be sufficient to cover the costs of the service provider.

Discussions at the Lahore workshop showed that there was little familiarity with this type of contract but that given the importance of reforms in canal operations to the productivity of the IBIS, the participants considered it was worth exploring such an arrangement.³

The Government of Punjab understands the significance of such reforms to the productivity of the IBIS, and has strong support from progressive farmers in the Province to explore this issue further. As with all such innovations, the implementation process should be very carefully designed. The Government of Punjab plans to convene a high-level committee representing all stakeholders to consider commissioning a feasibility study of what performance standards are appropriate for modern main and branch canals, what institutional options (including private sector provision) should be considered, and how increased cost recovery will follow improved performance. The governments of the other provinces indicated that they were not interested in pursuing such an approach.

If and when there is interest from a province to implement such an approach, the donors would have two key roles to play in helping finance such an initiative. First, the one-off costs for hiring transaction consultants to design the contract is high, and the province will need support from something like the new Water Resources Management Group (which is being formed in the IFC) or a conventional donor to help finance the design of such a contract. Second, assuming that such a contract were to emerge, there is a vital role for donors to play in financing “the wedge” illustrated in Figure 19 so that the system can make the transition to high performance and financial viability.

Establish Public–Private Partnerships for Optimal but Judicious Groundwater Use⁴

As discussed earlier, much of the economy in Pakistan depends on groundwater. Water supply for major cities such as Lahore, Peshawar, and Quetta has always been dependent on groundwater. In other cities including Rawalpindi and Karachi, and many small towns, groundwater has increased as a proportion of city water supply, and many industries prefer to use “clean and reliable” groundwater.

Groundwater is also important in Pakistan’s agriculture both in absolute quantity and in ensuring a reliable supply that is not achieved by surface irrigation. Even in the agricultural heartland of Punjab, an estimated 52% of farm water is from groundwater (albeit much of this derived from infiltration of surface water supplies). With the restraints on large-scale surface water development since 1976, agricultural expansion and intensification in the country has been driven to a large extent by the development of approximately 1,000,000 private tube wells in the country. It is estimated that 75% of the increase in water supplies in the last 25 years is to be attributed to public and private groundwater exploitation. The investment in these private tube wells is on the order of PRs.40-50 billion whereas the annual benefits in the form of agricultural production are estimated at PRs.250 billion, roughly equivalent to 5% of GDP. The dramatic increase in groundwater pumping is greater still in areas outside the canal command areas both in Balochistan and in the rain and flood dependent areas of KP, Sindh, and Punjab.

3. See Figure 12.

4. See more details in Annex 3 on groundwater.

So far, groundwater has been taken for granted as a free gift from nature in the form of a huge groundwater reservoir in IBIS and even in Barani areas; however, nothing is free in nature. Intensive groundwater pumping in many areas has put a lot of stress on the reservoir causing a continual decline in the water table and the deterioration of groundwater due to saline intrusion through lateral or upward movements.

While the problem can be described in general, system-wide terms, solutions will all be local and varied in different settings. There is no one-size-fits-all solution. Even within the IBIS, the decline in the water table may be acceptable in fresh groundwater areas (some areas in northern Punjab and areas along the rivers), whereas in areas lying close to the fresh/saline groundwater interface (larger parts of IBIS and Barani areas) a few feet may induce saline intrusion. Hence, monitoring and management measures in collaboration with users – particularly farmers who use more than 90% of groundwater – have to be implemented.

Without the awareness and active participation of the 5 million farmers, however, no regulatory measures are conceivable; any regulations developed and imposed without them will not be adhered to. Groundwater has not received serious attention in any province, even places like the Quetta Valley where the aquifer is being dewatered due to reckless and concentrated pumping.

This situation will only change when federal and provincial governments take the lead, and get targeted technical assistance to:

1. Develop a sound groundwater database and share it with users (farmers, farmers' organizations, urban managers). At present, data are patchy, and reporting is not always maintained. There are several data efforts, but they are spread over several organizations and are not coordinated. There are major gaps in KP, in Sindh, and in the non-canal commands in general and in the overall linkage of groundwater quality and quantity with water management.
2. Assign a single apex organization for groundwater management in each province and also in each major city. The responsibility for groundwater management should be placed with a strong organization. The focus should be on management of groundwater and coordination with other activities and land uses.
3. In Balochistan, compile an inventory of groundwater users and implement a broad range of recharge measures and water reduction measures. This can follow similar successful programs elsewhere (Andhra Pradesh, India) and systematically introduce a large range of recharge measures (soak pits, subsurface dams, spate irrigation, catchment protection).
4. Invest in developing information for the conjunctive use of surface and groundwater. In Sindh, this should lead to actions for rationalizing canal water supplies and investments in drainage and reuse; in Punjab, it should include developing on-farm water activities that reduce non-beneficial evapotranspiration and promoting groundwater recharge within the canal systems (by routing peak flows for instance).
5. Change the financing. Considerable scarce public money is wasted on groundwater. Examples include the continued operation of SCARP (Salinity Control and Reclamation Projects) tube wells in Sindh and KP, many of which are not functional, and the persistence of electricity subsidies in Balochistan.

Summary of Water and Agricultural Productivity

The recommendations are shown in Table 6.

Table 6: Action Plan for Agricultural Productivity

No.	Action/Project	Objective	Primary Responsibility	Time Line	Indicative Financing (\$million)
2. RAISING AGRICULTURAL PRODUCTIVITY					
2.1	On-farm water management	Increase agricultural productivity	Provincial agriculture departments, AJK, FATA, Gilgit-Baltistan	2012-2016	\$560
2.2	Public –private partnerships (PPPs) for small dams	Increase agricultural productivity	Provincial irrigation and agriculture departments, AJK, FATA, Gilgit-Baltistan	2012-2016	\$460
2.3	Improved management of main canals	Increase agricultural productivity	Provincial irrigation departments	2012-2016	\$500
2.4	Spate irrigation	Increase agricultural productivity	Provincial agricultural departments, FATA	2012-2016	\$300
2.5	Optimal but judicious use of groundwater	Sustainable productivity	Provincial agricultural department, FATA	2012-2016	\$100

The WSTF has identified three priority actions for increasing agricultural productivity. At the heart of the recommendations are an appreciation of the enormous gains that have been made by progressive farmers in enclaves during the last decade, and the central challenge of engaging private sector innovation in transforming both the existing IBIS and in developing new high-production models in other areas.

The first priority, improved OFWM, is a proven technical and political success that can continue to give large returns. The second, modernization of the construction and operation of small and medium-sized dams and intensification of spate irrigation, also has broad political support and can result not only in large increases in agricultural production but also in the development of a new high-value agricultural model that can subsequently challenge the standard operating practice in the IBIS. The third priority is the introduction of a new model for modernizing the infrastructure and institutions that manage the main and branch canals in the IBIS itself. Here the stakes are enormous with the ultimate goal being to transform the transparency and productivity of this enormous system. Entrenched opposition in the irrigation departments is huge, so it will only be possible to make progress incrementally through careful trial and error, and only if there is very strong political support from the chief ministers. Figure 20 illustrates which of the interventions is appropriate for different provinces and special areas.

External partners have the following very important supporting role to play in all three initiatives:

- providing funds for OFWM while insisting that the private sector play a larger role in service delivery;
- providing funds both for developing public-private models for modernizing the operation of medium-sized and small dams and spate irrigation systems and for financing initial efforts to establish this model, including strategic investments in appropriate infrastructure and equipment to improve the functionality;

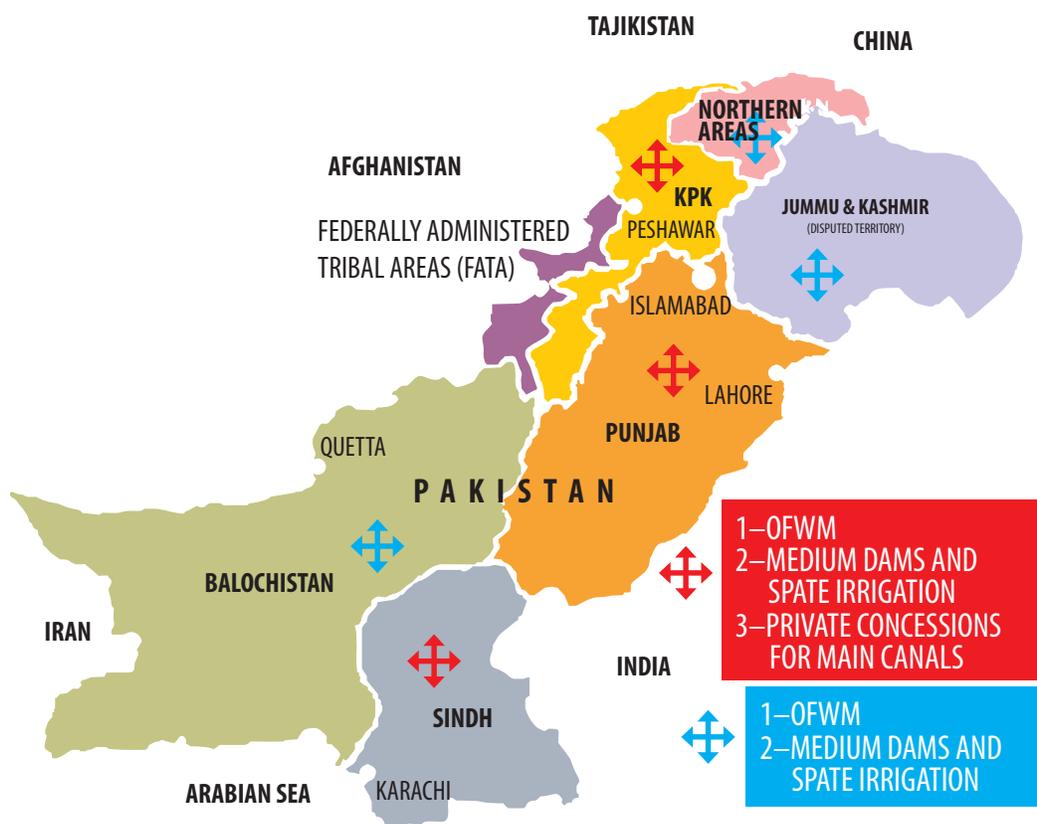


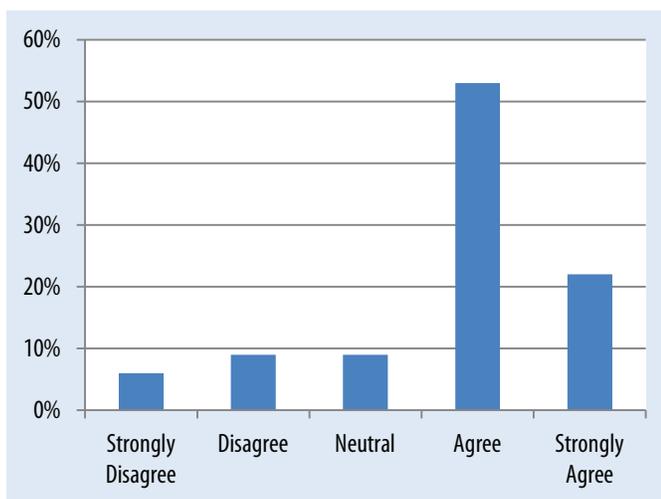
Figure 20: Potential Action Areas to enhance agricultural productivity in Provinces and Special Areas

- supporting, again in conception and execution, changes which will improve the performance of the main and branch canals, including, where there is commitment from provincial political leadership, the idea of private contracts for managing the main and branch canals in the IBIS; and
- moving away from an endless repetition of the cost-recovery mantra and supporting approaches that start with improving service delivery coupled with gradual increases in tariffs until the cycle of full payment for quality services is established.

Figure 21: Stakeholders' assessment of the value of the diagnosis and recommendations of the WSTF Report: Agriculture Productivity

Finally, as with everything else in this report, the WSTF can do no more than outline what might be sensible actions to take. Whether they are taken or not is not the business of the WSTF; rather, it is the business of Pakistani society and more specifically of political leaders who must decide whether they will lead such efforts, and of the business leaders and farmers and government officials who will have to make these efforts work.

The December stakeholders' consultation discussed the diagnosis and recommendations on agricultural productivity in considerable detail. The views of the stakeholders on this section of the report are shown in Figure 21.





LIVING BETTER WITH FLOODS

The Nature of “the Flood Problem” in Pakistan

Flood protection and management challenges vary considerably across the country. In KP and Balochistan and parts of the Punjab, the so-called “hill torrents” are usually highly beneficial, sustaining a large agricultural population. Occasionally flash floods cause serious damage, as did the devastating floods in Balochistan in 2005 and in KP in 2010. In the plains the problem is different. In all river systems, especially those with heavy silt loads, the greatest flooding problems are in the flat deltas.

This is so in Pakistan, where Sindh is basically a delta over which the Indus has meandered over millennia. Before human intervention, the Indus meandered because as silt built up in its bed, it sought, like alluvial rivers everywhere, lower lands and a new channel. This natural process creates havoc with human settlements, and so throughout the world, such rivers have been trained and confined by embankments within relatively narrow beds. But as with everything watery, solving one problem gives rise to another. In this case the bed keeps getting higher and higher, and soon the river is above the level of the land, as in the lower parts of Sindh. (To some degree, the trapping of silt in upstream reservoirs alleviates this particular environmental hazard although it in turn causes coastal erosion.) Over time the likelihood of embankment breaching increases as do the problems of drainage from flooded lands. When this coincides with unfavorable tidal conditions, the consequences can be disastrous. The inevitable consequence is (in the words of a 2005 assessment by the former Chair of the FFC) that “When a protection bund breaches in Sindh Province, inundations are prolonged, and the floods not only damage summer crops, but also interfere with the sowing of subsequent winter crops. The potential for economic losses and human suffering for the poor inhabitants of relatively cheap flood-prone lands near the river, are the greatest. In addition to millions of acres of irrigated land that is subjected to flooding, the country’s major rail and roads are also sometimes affected by super flood events that keep the infrastructure out of service for long durations.” This is what happened 5 years later in 2010.

Understanding Tradeoffs

The history of human civilization is largely a history of development in river basins and an associated Faustian bargain between benefits (the relative ease of obtaining food security, transport, and energy services) and threats from periodic flooding. Damage caused by floods is, therefore, not necessarily a failure of policy or execution but is in part a rational choice made by people who live in flood plains. The balance between the rewards and risks is different at different levels of development. In considering strategies for flood management, poor

people face greater risks from multiple sources, and are willing to assume an improvement in their lot now in exchange for a threat of a disaster in the future. It is also salient to note that while allocating scarce resources (like money and administrative capacity) to flood prevention can reduce their impact, there is also an opportunity cost incurred because those resources are diverted from other undertakings, such as producing more food and wealth.

There has long been an understanding in Pakistan of the devastating impact of floods, and there are long-standing efforts to manage floods better. Institutions (including the Federal Flood Commission [FFC]) have been built, and there have been large donor-financed projects dealing with understanding, predicting, planning, warning, and recovery. A developing country like Pakistan has to deal with a host of similarly difficult development and security issues simultaneously with few financial resources and limited institutional capacity. The former chair of the FFC has described the reality accurately: “As in many countries, attention to floods is episodic and goes into hibernation during periods of drought.”

Pakistan is now living through an extraordinary post-flood reality, with two of the largest floods on record occurring in 2010 and 2011. Part of the response to these is the episodic, temporary, outraged sort described above. Judicial commissions (in Pakistan and elsewhere) seek to identify villains. They don't examine the choices societies have made but instead issue edicts against particular officials, some of whom have indeed performed poorly but also some very good ones who face a daily barrage of chronic and acute crises and who just happened to be on the spot at the wrong time. Indignant commission reports that implicitly assume perfect foresight and look at just one problem do little to clarify what might be the right balance between risk and reward and offer little help in exploring how it might be possible to reduce risk without jeopardizing the rewards that come from proximity to a river. Overlooked, too, in the post-flood situation are the positives. Floods replenish the groundwater, wash out accumulated salinity, and are followed by record years of production. It is also important to recognize the extraordinary resilience of much of rural Pakistani society and the remarkable performance of some public agencies. Substantial areas recovered very well from the 2010 floods without major outbreaks of disease or conflict and without non-compensable losses of production.

The great challenge for the WSTF in the case of floods was to be clear and realistic and not to make endless lists of what might be done if there were no financial, institutional, or political constraints. Instead, the goal was to critically look at priorities, sequencing, and actual and potential political will. In short, the WSTF effort is to help make a break from what the former

chair of the FFC has described as a pattern of “short bursts of feverish activity stimulated by a flood event followed by long periods of complacency. . . as the memory of flood fades into the past, the motivation for action also passes away.”

Accordingly, the WSTF did the following:

- assessed whether conditions (both natural and economic) had changed such that a new balance between reward and risk might now be feasible and might make sense;
- assessed what experiences in other countries might offer Pakistan; and recommended a set of actions in consonance with financial and institutional capabilities that have or might have political backing and that might lower the risk from and costs of floods.

Changes in Natural and Economic Conditions

The massive back-to-back floods of 2010 and 2011 suggest that one of the major external factors, the frequency of extreme rainfall and runoff events, might be changing. What is the evidence?

Research based on long-term climate data shows that the monsoonal zone of Pakistan (a region that receives almost 65% of total monsoon rains) has shifted 80 – 100 kilometers from the northeast (upper Punjab and Kashmir regions) toward the northwest (KP and northwest Punjab). This suggests that the location of heavy rainfall during the monsoon will move from northeast to northwest. As a result, areas along the western rivers of the country (Indus and Kabul) will be extremely vulnerable to floods similar to the one in 2010.

While understanding of the interaction between climate change and glacial change is still rudimentary, it is highly likely that the general pattern will be a retreat of the glaciers of the Himalayan Karakoram Hindukush (HKH) region in Pakistan. As glaciers retreat, glacial lakes form behind moraine or ice ‘dams’ or inside the glaciers which can breach suddenly leading to the discharge of huge volumes of water and debris. Such outbursts have the potential to release millions of cubic meters of water in a few hours causing catastrophic flooding downstream with serious damage to life, property, forests, agricultural farms, and infrastructure. Known as glacial lake outburst floods (GLOFs), they can in a single devastating event result in major economic damage and social repercussions for a sizeable population living in the HKH belt in Pakistan. GLOFs often have catastrophic effects that result in heavy loss of human life and property, destruction of infrastructure, and damage to crop fields and forests.

Current (baseline) disaster management policies and risk reduction and preparedness plans in Pakistan address recurrent natural hazards but are not yet geared to deal with the new dimension of GLOF threats. According to a study conducted by the International Centre for Integrated Mountain Development and PARC, of the 2,420 Himalayan lakes identified and mapped in Pakistan, 52 were classified as potential GLOF threats. These glaciers and glacial lakes are the major source of water supply for agricultural, industrial, and hydropower development in the mountainous region. Records of past GLOF events in the Himalayas show that once every 3 to 10 years, a GLOF has occurred with varying degrees of socio-economic impact. In all, 35 destructive outburst floods have been recorded in the Karakoram region in the past 200 years; however, the frequency of GLOFs in Pakistan has increased during recent years to about 1 or 2 GLOFs per year. An understanding of the mountainous headwater of the Indus and especially of snow and ice conditions is lacking and/or inadequate in Pakistan. This is also a major gap in the knowledge essential for forecasting the hydrological behavior of the Indus River system.

Relevant Experiences in Other Countries

Pakistan is not the only country in the world to face the challenge of floods. Pakistani flood experts have long studied the experiences of others and have incorporated many of their findings into the country's official practice. This is not the place for a detailed review of such experiences, but two cases indicate that with good analysis and persistent political and institutional commitment, a lot can be done.

The first is that of Bangladesh where a combination of early-warning systems, preparedness, and adaptation of public buildings to act as safe houses has resulted in dramatic reductions in lives lost due to flooding and cyclones.

A highly relevant case with many similarities to the lower Indus is that of the Mississippi River in the USA. As with the Indus, there are great advantages from living close to the river, i.e. good land, adequate water, navigation, and energy, but there were also threats, so communities built levies to protect themselves and their property from floods. Eventually the Mississippi, like the Indus, was in a straightjacket, and when there was a large flood like the one in 1927, the river could no longer be contained, and there was chaos with hugely destructive economic and social consequences. There was no question of moving cities or of the large-scale evacuation of the river plain, but it was clear that large floods would come again and that it was necessary to have a much more orderly, planned, and disciplined way of “making way for the river.”

Over the subsequent 80 years, the Mississippi River Commission changed its strategy from one of “levies only” to one of levies to protect high-value assets and defined backwaters and floodways where the river could be directed in periods of exceptional flow. This land-use planning was accompanied by purchasing outright land in these backwaters and floodways (and often converting it into wetlands), or offering rural families an “options payment” for the right of the commission to flood their land in the event of a major flood. There was also a massive investment in strengthening operational-relevant knowledge of meteorology, of hydrology, and of hydraulics. Central to this process was the deep involvement of all stakeholders: the communities, the levee boards, the states, and the federal government. The great test of this new arrangement came in 2011 when the flood was in most places larger than in 1927. The result was extraordinary. The total area flooded was just 6 million acres far less than the 16 million acres flooded in 1927. The communities in the areas flooded were all prepared for this eventuality through many decades of engagement and communication.

The main message for Pakistan from these experiences is that while it is not possible to change the course of nature, with persistence, good institutions, and participation by all, wise investments in infrastructure, better maintenance of natural drainage paths, and serious management of irrigation and drainage infrastructure can greatly reduce the economic and social impact of floods, even in densely occupied flood plains.

What Has Been Done in Pakistan

As a consequence of the severe floods in 1976, the FFC was established in 1977 to integrate flood management planning with national policy. The objective of the FFC was to shift from a crisis-provoked approach to a risk management approach for effective flood management. The FFC is mandated to ensure coordination and management of floods and flood protection

works in an integrated manner. The FFC is also responsible for formulating a national flood protection plan that includes structural and non-structural elements and for its implementation in the provinces. In addition, WAPDA and the Pakistan Meteorological Department () also have important roles to play in terms of flood management including data collection, flood forecasting, and early warnings.

The National Disaster Risk Management Framework, launched in March 2007, provides an operational framework for disaster risk management activities in the country. It sets priorities for 5 years and identifies 9 priority areas for action: institutional and legal arrangements, hazard and vulnerability assessment, training, education and awareness, planning, community and local risk reduction, multi-hazard early warning system, mainstreaming disaster risk management into development, emergency response systems, and capacity development for post disaster recovery. It also recommends structures for managing disasters at the federal, provincial, district, tehsil, union council, and community organizations. It further identifies the roles and responsibilities of various stakeholders including ministries, departments, technical agencies, NGOs and development partners. The disaster risk management framework has been incorporated into the National Disaster Management Plan (NDMP) which is the overriding policy framework for disaster management in Pakistan and is being finalized by the National Disaster Management Authority (NDMA).

In 2008 and 2009, the governments of Punjab, Sindh, and Balochistan established provincial disaster management authorities (PDMAs) under their existing revenue departments. In KP, the PDMA was established as an independent agency directly reporting to the chief secretary of the province and the Gilgit-Baltistan Disaster Management Authority was established under the provincial home department.

These are all important initiatives and all are necessary, but experience with the 2010 floods shows that there is still a long way to go before there is an effective flood management system in Pakistan. It is worth highlighting major challenges that came to the fore in 2010.

The lack of maintenance of embankments is a very serious institutional and financial issue. In the words of the chair of the FFC in 2005, “Since 1958, with the transfer of major development works to WAPDA, functions of the provincial irrigation departments [PID] were reduced mainly to the operation and maintenance of the systems. PID managers have not been finding these functions sufficiently challenging, and over the years have lost much of their initiative, innovativeness, and morale. Their attention remains almost exclusively focused on the irrigation distribution network. Let alone the flood protection works, even the river barrages have been in a state of neglect. Deferred maintenance even of the most vital parts of the assets has become a routine practice with PIDs, which eventually results either in a disaster or in a major repair and restoration undertaking in the shape of an independent project.”

The 2010 floods brought this problem to the fore with a vengeance. At least some provinces are now starting on a new path. Punjab is committed to developing an asset assessment management plan for its major infrastructure (which includes barrages, embankments, and major drains). In some cases, significant re-design projects will be necessary; in all cases the exercise will identify responsibility for inspection, maintenance, and operation and will identify the costs of both regular maintenance and periodic replacement of these assets.

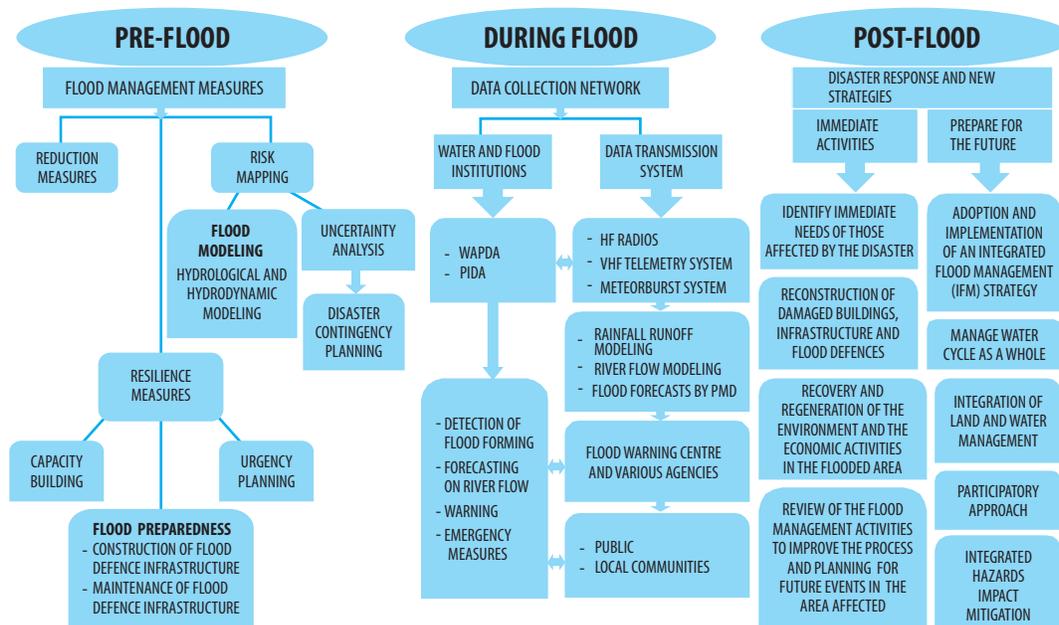


Figure 22: Flood management areas and priorities

Recommended Actions

Flood management is a complex challenge requiring multiple actions by many actors over a protracted period. This intrinsically complex task is much more difficult when financial and institutional resources are limited, and when political leaders and public institutions face a very wide range of chronic and acute crises. Accordingly, the WSTF has outlined in Annex 4 both the full set of actions necessary to make major inroads and a prioritized, sequenced set of actions that appears to have political and institutional backing and would have some immediate impact in reducing the economic and social damages from floods– the first steps down the long road to reach greater security from floods. Figure 22 provides a summary of the priority actions, divided into actions to do before, during, and after floods.

Pre-flood Actions

Watershed Management

- Develop an action plan for rehabilitating the lost forest cover, with particular emphasis in Gilgit Baltistan, FATA, AJK and KP. Provide alternatives for local communities for fuelwood and fodder.
- Develop a program that promotes community-based forest restoration including energy plantations, linear plantations on farms and agriculture fields, and linear plantations on water channels and rural road sides.
- Reassess the natural drainage paths in the plain areas, determine where the obstructions are from road, canals and railroad embankments, and reconfigure these obstructions to allow flood waters to drain.

A Community-Based Disaster Risk Management Program

Considering recurrent disasters in Pakistan, not only the public sector but also individual and community responses need to be enhanced. Community outreach at the union council level is needed to raise awareness and basic knowledge, to understand local vulnerabilities and ca-

capacities, to prepare disaster management maps, to establish community disaster management committee, and to enhance preparedness and emergency response capacities.

Maintenance of Existing Flood Protection Infrastructure

Embankments

- Along the rivers of Pakistan there are already more than 6000 kilometers of embankments intended to protect infrastructure and people from floods. A number of them, including some very large ones like Tori Bund, failed to serve their purpose during the 2010 flood. Priority actions include the following:
 - Repair existing damaged embankments and control all the embankments with regards to durability and possible invisible damage.
 - Construct new priority embankments to complete the network in order to achieve maximum security for people.
 - Work on a national inventory database of embankments and breaching sections of barrages, document their current conditions, and include the information in danger and hazard maps.
 - As some of the irrigation functions of the PIDs are passed to both farmers' organizations and the private sector, re-engineer the PIDs so that they have much greater accountability and capability for maintaining and operating flood infrastructure. This includes developing asset management plans and committing resources.

Protection of essential public infrastructure

- Provinces need to develop plans for prioritizing the protection of high-value public infrastructure (including transport, energy, water supply, hospitals and police stations) and plans for deploying them during floods.

Integrated Flood Management

Develop a legal framework for flood management

- This includes water laws, river laws, disaster management laws and land use planning laws that define backwaters and floodways and regulate their development, and regional and municipal bylaws that require compliance with building and safety codes.

Effective floodplain zoning and enforcement

- Efforts in this field have improved in the last year (originally they were scheduled in the ADB-funded Second Flood Protection Sector Project, 2000–2007 but were later withdrawn for social and political reasons). The flood of 2010 was a graphic demonstration that the Indus cannot be contained by embankments and that there is a need for an overall philosophy of “making way for the river.” This means focusing embankment protection on high-value infrastructure and cities and defining backwaters and floodways and land-use practices. An important element is the purchase of land or of options to land in designated backwaters and floodways.

Revisit key drainage infrastructure and management

- The 2011 Sindh floods provided further evidence of the need to have an orderly process for making way for the water. Excess water in upper areas was routed, including by the Left Bank Outfall Drain (LBOD), to the tail areas where they caused dramatic flooding.

In the view of the WSTF, it is unreasonable to expect the LBOD (and other saline water drainage infrastructure) to double as flood infrastructure because the costs of such massive infrastructure would be exorbitant, but it is equally clear that the philosophy of “making way for the water” must apply to drainage systems. These systems must be designed so that backwaters and floodways are identified, and zoning, community involvement, and compensation form part of the living-better-with-floods package. The Government of Sindh is particularly keen to develop and implement such an approach.

Improving Forest Laws

- This task was previously managed by the Pakistan Environment Ministry (devolved under the 18th amendment to the constitution) which allocated responsibility to the National Council for Conservation of Wildlife in Pakistan and the Pakistan Forest Institute as special organizations that would work specifically on this topic, but enforcement remains weak.

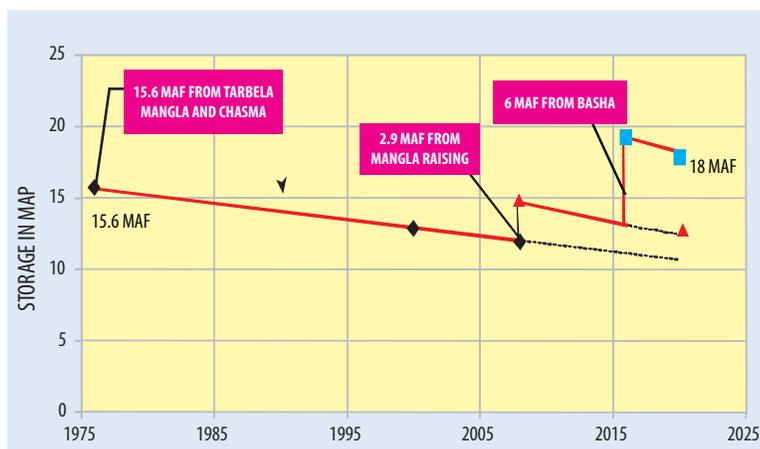
Put the National Flood Protection Plan (IV) into Action

- The FFC is responsible for formulating a national flood protection plan (NFPP) including structural and non-structural elements and ensuring its implementation in collaboration with the provinces. To date there have been four plans, and the last one (NFPP IV 2008–2018) is still being revised.
- This is a very large program with a cost of about PRs50,000 billion, over 80% of which is for infrastructure in the provinces. Despite the floods of 2010 and 2011, the NFPP is not high on the political agenda. The NFPP IV (due in 2008) is not yet finalized or approved. In the 2010–2011 Public Sector Development Program - PRs740 million was allocated for the completion of 3 schemes (on-going/new) in Punjab, 7 schemes (on-going/new) in Sindh, 6 schemes (on-going/new) in KP, 23 schemes (on-going/new) in Balochistan, 10 schemes (on-going/new) in FATA, 1 scheme (on-going/new) in AJK and 4 schemes (on-going/new) in Gilgat Biltistan. Only PRs280 million was actually released for these purposes.

Maintaining, Improving and Expanding Storage Infrastructure

- As described earlier, in comparison with other countries, Pakistan is in desperate need of additional multi-purpose storage capacity and has an ambitious but sensible and do-able plan for initiating eight major projects in the next few years. Some of these dams (such as Munda in KP) would have major local impacts on floods, but, as shown in Figure 23, loss of storage due to siltation means that even after the raising of Mangla and the building of Basha, Pakistan would have only a little more storage (18 MAF) than it had after the building of the replacement works in the 1970s (15.6 MAF). A long-term, persistent and regular program for large-dam construction is essential.
- Building new dams and raising old ones isn't the only option for enhancing water

Figure 23: The evolution of storage in the Indus Basin
Source: World Bank 2003



storage capacity. There are other possibilities that need to be explored such as off-channel flooding of deserts and depressions, as well as making use of the largest storages in the country, namely the shallow aquifers. Because of extensive occupation and multiple cropping of the flood plain, areas for recharging the aquifer are practically limited, but recharge can be increased through smart, conjunctive management. Dedicating specific areas as backwaters can help, as can the deliberate recharging of depressions and wetlands. This would serve not only to reduce flood damage but also to recharge aquifers and conserve environmentally-vital wetlands.

Operational Flood Management

Improve Flood Management Coordination and Communication

Flood conferences are normally held well before the onset of the flood season and then post flood season to assess damage and remedial works for flood impact mitigation. These are chaired by the FFC and include the PMD, Armed Forces, NDMA and PDMA. This is a good practice that needs to be continued and strengthened. Improved communication among agencies and with the public is vital and can be improved. The Flood Manual needs to be reviewed and updated.

Improve the Existing Flood Early Warning System

Priority needs to be given to (i) hydrologic model recalibration for the Jhelum, Chenab, Ravi and Sutlej watersheds, (ii) improving the meteorological input to the forecasting system, and (iii) an improved data integration within the flood early warning system. Lessons need to be learned from the system that was established 15 years ago. There is a need to improve its outreach and functionality, including decision-making procedures, in addition to improving its accuracy.

National Multi-Hazard Early Warning Plan

There are efforts under way to establish a multi-hazard early warning system to deal with disasters in a holistic manner. This is a sound approach because it is not possible to build separate capacity for every type of hazard, and because catastrophic events are very often interrelated. Such a system is in planning in the NDMA in collaboration with the Japan International Cooperation Agency (JICA) and addresses tsunamis, river floods (including systemic and flash floods, and GLOFs), landslides, cyclones and storm surges, and drought.

The Highest Priority Flood Management Actions

In line with the mandate of the FODP, the WSTF went through an intensive process of setting priorities. The highest priority items are discussed in detail in tables in Annex 6 that describe why they are immediate priorities, what has been done and what would be done differently, what difference the proposed action will make, what institution should be responsible, and what resources and other assistance is required. The highest priority items comprise a program that would cost about \$100 million over the next 5 years and would include the following:

- community-based disaster risk management for 1000 communities at a cost of about \$5 million targeted at areas most at risk such as flood plains or the areas at the tail of the irrigation systems, where all excess water ends up during unusually heavy rainfall;
- a review of public infrastructure because the recent flood in Lower Sindh shows the floods have multiple causes, but the absence of escape routes and the blockage of natural drains by road and irrigation infrastructure makes everything much worse;

- a multi-hazard early warning system plan under the NDMP that would cost about \$70 million over 5 years;
- a national disaster management plan at a total cost of about \$5 million;
- a review of flood management activities to improve the process and planning for future events at an estimated cost of \$1 million including revisiting actual operating procedures of the irrigation and drainage systems during unusual weather events; and
- an updated flood forecasting and early warning system at an estimated cost of \$12 million.

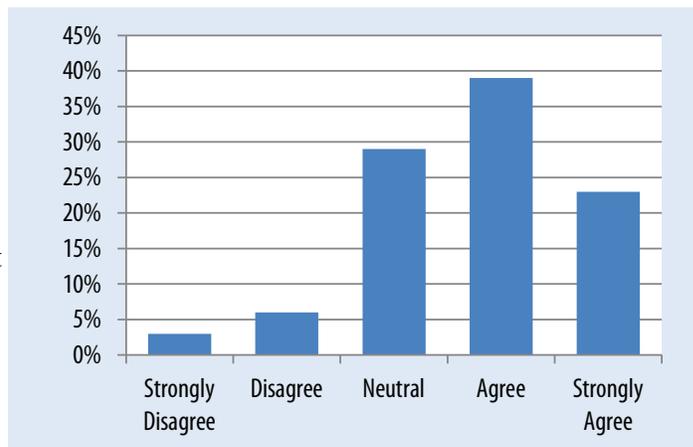


Figure 24: Stakeholders' assessment of the value of the diagnosis and recommendations of the WSTF Report: Living with floods

The recommendations regarding flood management are shown in Table 7.

Table 7: Action Plan for Flood Management

No.	Action/Project	Objective	Primary Responsibility	Time Line	Indicative Financing (\$million)
3. LIVING BETTER WITH FLOODS					
3.1	Construction on new dams (see Item #1 above)	Reducing flood peaks	WAPDA	2012–2020	Included in #1
3.2	Long-term institutional development by partnership with an organization which has been successful (eg. the Mississippi River Commission)	Capacity building	FFC and the provinces	2012–2016	\$20
3.3	Key elements of the National Flood Protection Plan IV (2008–2017), including: <ul style="list-style-type: none"> • Floodplain zoning and enforcement • Early warning systems • Community-based disaster risk management • Flood protection Infrastructure 	Pre-, during and post-flood management	FFC, Pakistan Meteorological Department (PMD), federal and provincial disaster management agencies, AJK, FATA, Gilgit-Baltistan, and Provincial governments	2012–2016	\$500
3.4	Some federal and provincial actions including: Asset Management Plans Rehabilitation and maintenance of existing infrastructure and new construction	Rehabilitation and maintenance of flood protection schemes (including spurs and bunds), estimated at \$500 million by the FFC	Provinces, AJK, FATA, Gilgit-Baltistan,	2012–2016	\$500-\$600
3.5	Watershed management in AJK, Gilgit-Baltistan and KP	Reduce severity of hill floods and reduce erosion	Federal government, AJK, Gilgit-Baltistan and KP	2012–2016	\$50

The December stakeholders' consultation discussed the diagnosis and recommendations on flood management in considerable detail. The views of the stakeholders on this section of the report are shown in Figure 24.



SECURE, PRODUCTIVE AND SUSTAINABLE CITIES

Contemporary water management in any country arises out of the historical water challenges it faces. In Pakistan, the great challenge was providing water for irrigation; it is for this purpose that the water infrastructure and institutions were formed, and the laws and irrigation bureaucracy that continue to dominate the water scene. Pakistan, however, is changing rapidly. The proportion of the total population living in urban areas has increased from only 17% in 1950 to 33% in 2000 and will likely increase to 50% by 2030. As this demographic and economic change takes place, the water management system of Pakistan has to address a new set of challenges.⁵

The current Five-Year Plan is built on the belief that urban centers (which already account for almost 80% of GDP) will be the engines of growth for Pakistan. For purposes of this report the essential point is that productive cities depend on a platform of predictable, affordable, sustainable, and high-quality water and sewerage services. The health and well-being of households in and around the cities and towns, too, depend on decent water and sanitation services. The growing cities depend on surrounding areas for bulk water and for a place to discharge their concentrated toxic industrial, hospital, and human wastes.

The state of the urban water sector in Pakistan is abysmal. As shown in detail in Annex 5, coverage is low, service quality is poor, large and growing subsidies are required to maintain even these services, utilities are overstaffed, large amounts of toxic waste is poured into neighborhoods and in the hinterlands, and many cities are facing growing difficulties in obtaining adequate, good-quality sources of water.

While reforms of irrigation systems everywhere are difficult both politically and technically, the urban water challenge is a relatively easy one, in which experts describe the problems in the same way, in which there are only mild disagreements about the solutions to be administered, and where there have been remarkable results when cities have implemented the solutions. The big question is whether there is a willingness to make the critical political decisions.

Diagnosis

As shown in Figure 25, the WSTF method for assessing the water and sewerage services distinguished between (i) challenges in obtaining an adequate quantity of bulk water of reasonable quality, (ii) challenges in managing the utility that delivers water and sanitation services to households, and (iii) the impact of waste from the city on the people in and downstream from the city.

5. Annex 5 provides more detail on the challenge of urban areas

The WSTF focused on the capital cities of the four provinces and broadly diagnosed the situations therein.

Bulk Water Supply

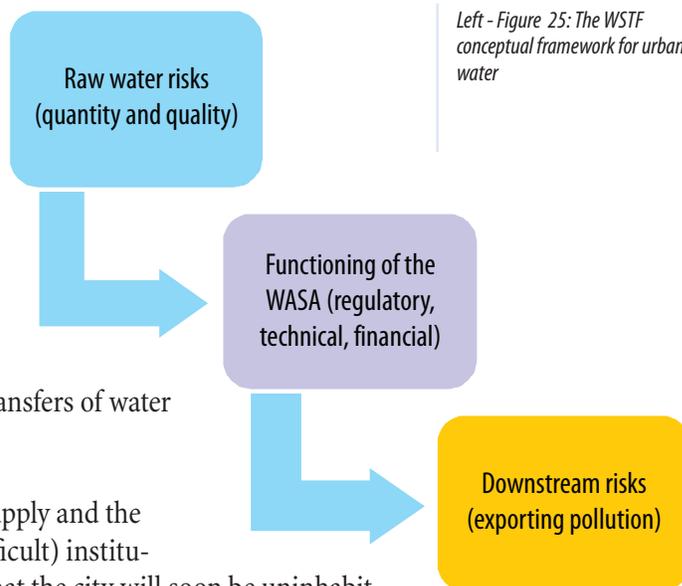
The situation is satisfactory in most cities primarily because until now, the quantity demanded by cities has been small compared to that required for agriculture; However this situation is changing rapidly as groundwater becomes less accessible and of lower quality, and there are no mechanisms that enable cities to reach agreements with farmers over voluntary transfers of water to the former.

In Quetta, however, the absence of a reliable bulk water supply and the apparent unwillingness to make the necessary (albeit difficult) institutional changes to restrict groundwater pumping means that the city will soon be uninhabitable given its present and projected population. In short, the bulk water situation varies, but is becoming serious in many cases and dire in some.

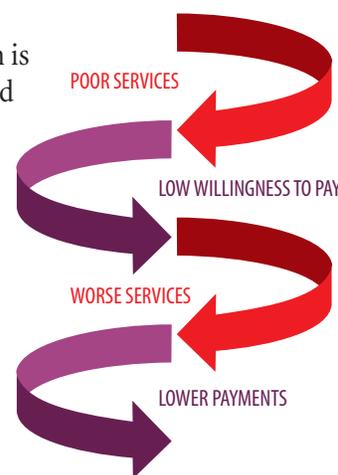
Utility Performance

In general, utility performance in Pakistan is between bad and awful. All water utilities in the country are trapped in a “vicious cycle” in which tariffs are much too low, there are no resources for maintenance let alone investment, services cannot expand, and the service quality continues to decline (Figure 26). The heart of this problem is institutional. The legal and regulatory environment is informal and politicized and disables rather than enables. Decisions on who will run the utilities, how many people will be employed, where services will go, and what the tariffs will be are made by the politicians; utilities are equally dependent on politicians for subsidies, and are accountable to these politicians rather than their customers.

The result is a litany of massive and growing financial deficits, very high levels of water unaccounted for, large proportions of households and industries supplying themselves or relying on water tanker trucks, and no resources to invest in critical public goods, namely sewage collection and treatment.



Left - Figure 25: The WSTF conceptual framework for urban water



Below - Figure 26: The vicious cycle for urban water utilities

Table 8: The state of the urban water sector in Pakistan

Challenges	Causes / impacts
Unsustainable financing	<ul style="list-style-type: none"> • Infrequent tariff revision (last increase dates from 7 to 20 years) • Electricity costs amount from 35% to 55% of O & M costs, bills are partly paid (adjustment parameter of the accounts) • Deferred maintenance by lack of liquidities • Increased reliance on subsidies from the Province • Low collection rate of bills (from 20% to 82%, fair performance of Rawalpindi and Lahore) • Low water tariffs (between 1 and 2% of average household income) • Parallel service providers (tankers, donkey carts, water vendors)
Poor customer service	<ul style="list-style-type: none"> • The consumer is not considered as a client • Few competent staff dedicated to client attention • Poor call centres and customer complaint statistics (good steps forward in Rawalpindi) • As a consequence, reluctance of customers to pay the bill (particularly strong in Karachi) • Unpredictable intermittent water supply of dubious quality
High non-revenue water	<ul style="list-style-type: none"> • A lot of illegal, not billed customers (from 10 to 35% of the consumers) • Visible leak repair is not a priority • Un-metered consumption generates wastage by customers • No precise estimate of NRW (poor metering): range is 30% to 45% in quantities of water, before taking into account the collection rate • Total lack of action plan to reduce NRW
Human resources	<ul style="list-style-type: none"> • Managers know their job, their staff, their facilities • Demotivation due to lack of evaluation, of financial means • No incentive (except bill collectors in the best WASAs), no hire and fire power for the managers • All managers complain of political influence (rare subsidized investments come with already decided project, hiring of unnecessary staff. . .) • Overstaffing • No compass: no performance indicators (except in Punjabi WASAs, WSP project) • Nearly no training
Poor water quality	<ul style="list-style-type: none"> • Tap water is not potable (frequent bacteriological contamination) • The visited filtration plants are correctly run, water is disinfected • Tube wells : lack of chlorination in many places • Intermittent supply generates depression in pipes and contamination in the network (increased by use of sucking pumps by customers) • National standards exist (NEQS), sampling and water analyses in every city
Water quantity	<ul style="list-style-type: none"> • Is not the main bottle neck: production per capita remains high despite population growth (3 to 5%), except Quetta • Depletion of ground water table is an important issue in some cities • Bulk production is not measured • Non-existent domestic metering except in Lahore (16% of customers) • Industries pump mainly from ground water without any control
Sanitation	<ul style="list-style-type: none"> • Nearly no effluent treatment, except CDA (15% of effluent treated, capacity 30%, good technical management) and Karachi (15% of treatment capacity, rehabilitation needed for 1 of the 2 WWTP) • Various treatment processes : activated sludge, trickling filters, , anaerobic ponds, stabilization ponds • Nearly all effluents flow to natural bodies (rivers, drains, canals, water table) • A lot of solid waste in drains, canals and collectors • Insufficient sewerage network in many areas • Nearly no collector repairs • Jetting vehicles available to solve collector blockages

Wastewater Collection and Treatment

About 1% of wastewater collected in Pakistan is treated in large part because tariffs are too low to cover even the cost of the primary service (water supply). Pressured by anxious homeowners and industries, utilities and cities attempt to evacuate as much sewerage and storm water as possible out of the city, but then it is dumped on the poor people who live in the periphery and on rural people who live downstream. The waste comprises household sewerage, hospital wastes, and wastes from large and small industries. The cost in acute and chronic disease is enormous. An overview of the state of Pakistan's major water utilities is given in Table 8.

Remedial Actions

- The challenges Pakistan's urban utilities faces are similar to those in many developing countries.
- The technical solutions are known to the many WASA managers and professionals and have been identified in the master plans for Karachi and Lahore prepared in collaboration with JICA.
- With strong, persistent political leadership, many cities in the developing world have made dramatic turnarounds and provided accountable, financially self-sufficient, high-quality services to their populations. To cite just one example, in the area served by Manila Water in the Philippines, over the past decade coverage has increased from 70% to 100%, supply has improved from intermittent to constant, non-revenue water has fallen from 65% to 11%, and the utility has generated substantial surpluses that have been dedicated to improving sewerage collection and treatment.

Recommended Reforms depend on Political Leadership

Every successful utility reform in the developing world has relied on the unstinting commitment from the highest level of political leadership.

The WSTF team is acutely aware that political leaders in Pakistan (in this case the chief ministers) face a host of challenges. They have limited financial, institutional and political resources and so must focus primarily on those issues which they judge to be of the absolute highest priority for their cities. In many cases this will mean that they quite legitimately do not choose to spend their political capital on dealing with water and sewerage services.

The WSTF attempted to gauge the level of commitment to reforming the water utilities in the capital cities. The Government of Punjab has espoused a water sustainable Lahore as a high priority (along with “becoming a regional agricultural powerhouse”). The WSTF team was impressed by the commitment to urban water reform of the KP government in Peshawar. The Government of Balochistan declared water for Quetta to be their highest priority and the Government of Sindh recognized that water and sewerage for Karachi is important.

Respecting the fact that it is chief ministers who are responsible and accountable and that they have to decide whether water is or is not their priority or not, WSTF recommendations for Punjab and KP (where the task force perceived some appetite for reform) were different from those for Balochistan and Sindh (where the task force did not detect any appetite for reform).

Recommendations where there is willingness to reform

It is frequently asserted, especially by development agencies, that the solution is to increase tariffs. In project after externally-funded project in Pakistan, ambitious tariff goals have been set and never met. Successful experience shows that the tariff issue cannot be addressed in isolation since customers will reasonably resist paying more for a poor quality unaccountable service from a bloated institution that is not accountable to them. Nevertheless, the fiscal bleeding that is a result of the increasing gap between un-revised water tariffs and revised electricity and manpower costs is unsustainable and must be addressed in part by annually indexing water tariffs. Given the low level of existing tariffs, this measure is affordable.

After making this vital adjustment, the process must begin at the other end. At a policy level this means a strong commitment at the highest political level (in Manila it was the President of the Philippines) to re-structuring the utility so that managers are selected on the basis of

competence and customer orientation, so they can hire and fire staff, and so there is a regulatory structure that fairly balances the interests of customers, the utility, and the government. The customer must first experience a new culture of responsiveness and improved quality of service. Only then can the discussion start about the costs incurred for providing such a service efficiently. Customers must be informed that they will eventually, typically over a period of several years, pay the full cost of providing this service as illustrated in Figure 27.

In contrast to irrigation, however, the road in the urban sector is much better trodden, the successful outcomes more frequent, and the variations in forms for achieving this much narrower.

The WSTF engaged in detailed discussions with government officials and water supply and sanitation managers in Hyderabad, Islamabad, Karachi, Lahore, Peshawar, Quetta, and Rawalpindi. In KP and Punjab, political leaders understand that the status quo constitutes a serious impediment to the competitiveness of their cities and to the health and well-being of the people who live in and around them and have expressed a commitment to consider major institutional reforms for these and other major cities in their provinces. The WSTF team worked closely with them and with water supply and sanitation managers and staff and identified the set of next steps to be taken (Table 9a).

Table 9a: Urban water and sanitation recommendations where there is evidence of political commitment to consider institutional reform (part 1 of 2)

Punjab—Lahore	Khyber Pakhtunkhwa—Peshawar
<ul style="list-style-type: none"> Nearly no effluent treatment, except CDA (15% of effluent treated, capacity 30%, good technical management) and Karachi (15% of treatment capacity, rehabilitation needed for 1 of the 2 WWTP) Various treatment processes : activated sludge, trickling filters, , anaerobic ponds, stabilization ponds Nearly all effluents flow to natural bodies (rivers, drains, canals, water table) A lot of solid waste in drains, canals and collectors Insufficient sewerage network in many areas Nearly no collector repairs Jetting vehicles available to solve collector blockages 	<ul style="list-style-type: none"> Create one single WASA, merging all water services entities except Cantonment Develop mechanism for automatic annual tariff revision based on inflation Develop and implement measurement and regulations for ground water abstraction Initiate steps to reduce Non Revenue Water (NRW)

An important part of the discussion within the WSTF team and with the provinces, relates to the prospects of private sector participation in providing urban water and sanitation services. There are a few cases (Brazil, Cambodia, Chile, and Uganda) where public utilities have managed to achieve good levels of performance. In some cases (Cambodia and Uganda) this has been the result of extraordinary, charismatic leadership. In other cases (Brazil and Chile) it was a result of a general improvement in public sector management accompanied by closer partnerships with the private sector. These cases notwithstanding, there have been many more cases of promise after promise to achieve a new culture in the institution that has repeatedly failed. In light of these repeated failures, many countries have found that involving the private sector can be a decisive step in getting the architecture right (with differing roles for regulators and operators) for focussing on customers, attracting capital, gaining from international experience, and in improving the quality of human resources in the sector. After a long and futile donor-driven attempt to get a private operator in Karachi, what is clear from both Pakistan and international experience is the following:

- The process can succeed only if there is committed and effective political leadership in which the equivalent of the chief minister takes a leading role and mobilizes a broader

set of stakeholders in support of the process so that a private operator can play a major and productive role.

- The local private sector must be well aware that its ability to perform and attract investment depends on the functioning of key infrastructure (including water) and is therefore a key partner in urban water reform and will sometimes (as in the case of the Ayala Corporation in the Philippines) engage as a service provider primarily to increase overall city competitiveness.
- This has been the means for successful reforms in cities where the starting conditions (the income of users and human resources) are less propitious than those in a city such as Lahore.

Members of the WSTF all agree that a private operator in the form of a local/international consortium could play a major positive role and that the initial private sector involvement would be “shallow” sort (a management contract) and not “deep” (a lease or concession contract) (Figure 15). The WSTF also agrees that a critical element in such a contract would be a well-defined contribution from a multilateral or bilateral partner to help structure it (the IFC work in Manila is an outstanding example) and to help finance the “declining wedge” (Figure 19) so that performance could start to improve (Figure 27).

In recent years developing countries the traditional private sector companies involved in urban water have only engaged with developing countries when risks are perceived to be low. However, there are some first-class utility operators which have developed in middle-income countries (like Brazil and the Philippines) and one or two of these could be interested in a city like Lahore. Attracting such operators would require strong leadership from the Chief Minister of an interested province.

While it may be possible to attract a private operator for a city like Lahore, this cannot be a universal solution. Every city in Pakistan needs major improvements and as the number of private operators will certainly be limited, an interesting alternative lies in public management contracts. This also requires strong political commitment as the principle is to set up a tailor-made management contract between the province and a group of motivated water utility managers under the leadership of the existing (or a new) leader. Annex 5 describes the mechanism of such a contract. Both systems (private or public management contract) require that a provincial regulatory body is launched to monitor utility’s performance.

Recommendations where there is less willingness to reform

Discussions with the Task Force showed that in Sindh and Balochistan provincial leaders understood the value of a well performing water utility and that they understood that they faced grave challenges in service provision. In Balochistan, the leadership was aware that Quetta was running out of water and that its very existence was threatened. In both cases, however, it was apparent to the WSTF that provincial leaders had other priorities and were not ready to explore the difficult reforms that might put their cities onto a sustainable path. These cities do, however, have committed and able professionals in the water utilities. The WSTF worked with these colleagues in defining a realistic set of priorities that could be pursued given the lack of willingness to commit to a reform process. These are listed in Table 9b.



Figure 27: The virtuous cycle for urban water utilities

Table 9b: Urban water and sanitation recommendations where there is no evidence of political commitment to consider institutional reform (part 2 of 2)

Sindh	Balochistan—Quetta
<ul style="list-style-type: none"> • Initiate benchmarking based on a few key indicators • Initiate steps to reduce non-revenue water (NRW) • Prepare and implement customers' relationship strategy • Develop mechanism for automatic annual tariff revision based on inflation • Control industrial discharge to natural bodies, begin with the most contaminating industries/activities • Develop the existing "Sindh Cities Improvement Project", ADB funded (cluster of cities in Sukkur area, run by an autonomous company) 	<ul style="list-style-type: none"> • Prepare to reduce the population of Quetta unless there is a credible plan to stabilize the ground water aquifer (1000 feet deep, 7 feet depletion a year), by reducing dramatically pumping through irrigation tube-wells • Initiate steps to reduce Non Revenue Water (NRW) • Develop mechanism for automatic annual tariff revision based on inflation

Sanitation and Domestic and Industrial Wastewater

The third element of the WSTF approach to city sustainability was to examine the impacts of inadequate sanitation, especially the impact (very large in some cases) of wastes from growing cities on communities at the periphery and downstream. The WSTF view is that it is useful to separate consideration of domestic sanitation from industrial waste.

With regard to domestic wastewater collection and sewage treatment, it is clear that this is very important for health in and outside the city and that this is a classic public good and should have high priority in public funding. It is, however, equally clear that when governments have to provide large subsidies to utilities to provide water services (as is the case throughout Pakistan), this will have priority and there will be nothing left to invest in collecting and treating domestic waste. In short, the first step to improving sanitation is to make the water utilities financially viable.

The situation with regard to industrial waste collection and treatment is different. First, the environmental and health consequences of industrial wastes are usually far more serious and lasting than the consequences of domestic waste. Second, it is usually not difficult to get big companies to comply, but it is much more difficult for the small enterprises that are dominant in Pakistan. There are useful lessons for Pakistan in a detailed evaluation of a series of major industrial pollution control loans which concluded the following:

- A combination of subsidized credit for industrial pollution control investments and grant-financed common effluent treatment plans and effluent charges, strengthening of pollution control boards have made some impact.
- Public disclosure of polluting industries, especially in cases where compliance problems persisted, has been cost effective.
- It is essential to start with pilots and monitor, evaluate, and learn before going to scale.

The Critical Role of Development Partners

Like so much infrastructure in Pakistan, the process followed is what has been described as the "build-neglect-rebuild" model. Primary responsibility for this rests with Pakistan's political and administrative leaders, but Pakistan's "friends" have played an important enabling role by repeatedly pumping good money after bad. In the urban water sector, where the outlines of a much better-performing sector are easy to discern and where the critical transformative ingredient is domestic political will and commitment, Pakistan's friends should no longer play this enabling role. Resources are limited, and the opportunity costs are high. The position of

the FODP and external donors in general should be clear to the provincial leaders that:

- This is your province and we respect your responsibility to set priorities which means that everything cannot be a priority.
- If improving the performance of your urban water and sanitation services is a priority, then we are willing to help with technical assistance to make sure that your process has access to the lessons of experience from around the world;
- by providing specialised expertise to help establish an enabling legal and regulatory framework and an effective architecture; and
- to break the vicious cycle by financing the operational capital expenditures you need to improve the service under medium-term management contracts.
- If the provincial leadership is not ready to reform the urban water and sanitation utility, then development partners should not finance investments in this sector, but will remain open to helping in the areas where there is more commitment.
- Development partners should be willing to finance— on a pilot basis at first— programs for controlling industrial pollution building on the lessons of experience in similar settings.

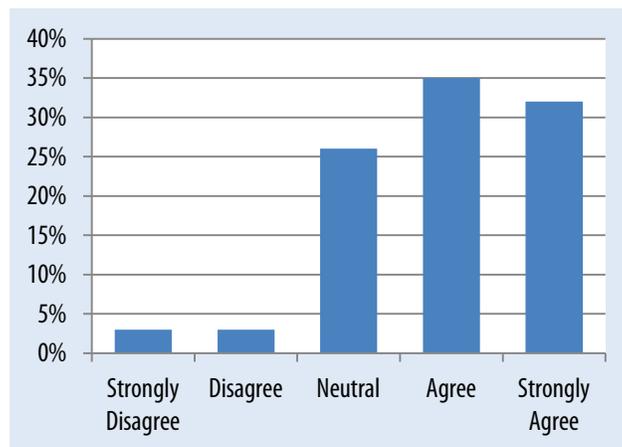


Figure 28: Stakeholders' assessment of the value of the diagnosis and recommendations of the WSTF Report: Sustainable cities

Recommended Actions

The recommendations regarding sustainable cities are shown in Table 10.

Table 10: Action Plan for Sustainable Cities

No.	Action/Project	Objective	Primary Responsibility	Time Line	Indicative Financing (\$million)
4. SUSTAINABLE URBAN SERVICES					
4.1	Automatic tariff revision	Improve financial sustainability	Provincial governments and WASAs	2012	No cost action
4.2	Start reducing non-revenue water (in 20 utilities)	Improve service quality and financial sustainability	WASAs	2012-2016	\$5
4.3	Defining groundwater entitlements and regulating groundwater abstraction	Secure resource base	Provincial governments	2012-2016	\$10
4.4	Punjab Municipal Water Act	A model for urban water reform	Provincial governments	2012-2016	\$4
4.5	Save Quetta Ground Water	Help secure the future of Quetta	Government of Balochistan	2012-2106	\$40
4.6	Finance "wedge" to get to sustainability	Sustainable services	Provincial governments	2012-2016	\$35 for one large city
4.7	Infrastructure for quality water services if they reform	Service quality	Provincial governments	2012-2016	Between \$250 and \$700 per large city
4.8	Pilot industrial pollution control projects	Environmental health	Provincial governments	2012-2106	\$50 million per city

The December stakeholders' consultation discussed the diagnosis and recommendations on sustainable cities in considerable detail. The views of the stakeholders on this section of the report are shown in Figure 28.

BUILDING KNOWLEDGE AND CAPACITY

Diagnosis

Pakistan's water managers and users face a situation face large risks and uncertainties. There is uncertainty about:

- how the very complex integrated glacier/mountain/river/land/groundwater/coastal ecosystem functioned in its natural form;
- what the impacts of the massive changes that man has imposed [primarily in the form of the world's largest contiguous irrigation system (Figure 29)] on the stocks and flows of water, on levels of groundwater and critical chemicals like salt (Figure 30, *overleaf*), and on ecosystem functioning and services;
- the impact of climate change will be in terms of rainfall, glacial mass and melt, snow-melt and changes in evaporation.

The risk arises because the country is effectively built on a single little-understood, massively-changed, and vulnerable water system.

Countries with far less water dependency and far simpler systems have understood that securing their water assets requires very large investments in acquiring and applying knowledge and have made long-term commitments to train people and gain the resources to build and share this knowledge base. Given its almost -unique combination of complexity, vulnerability, risk, and uncertainty, the returns on these would be even higher in Pakistan than in other water-dependent countries. The disturbing reality is that as knowledge capacity has grown in other water-dependent countries, the capacity in Pakistan has remained narrow and actually declined. Reversing this trend is a vital facing the Pakistan water sector.

Pakistan can make a lot of progress in this area and can learn from other countries, and Pakistan has enormous intrinsic human resources to deploy. Experience suggests the following priorities:

- It is essential that the whole of the knowledge base is more than the sum of its parts. There is need for a basic architecture which makes sure that modules developed for different places, scales and purposes (for example, to support farmers' organizations, on the one hand, and to provide predictions of flood flows in the delta, on the other) are developed in a way that they can contribute to a single, integrated understanding of the basin. The corollary is that piece-meal construction of a knowledge base will not do the job.
- The knowledge and capacity strategy has to focus at least as much on the demand for knowledge as on the supply mechanisms. For specialists like meteorologists or hydrologists, development of knowledge is the end, not the means to the end. Time and again

6. More detail on this action area can be found in Annex 6.

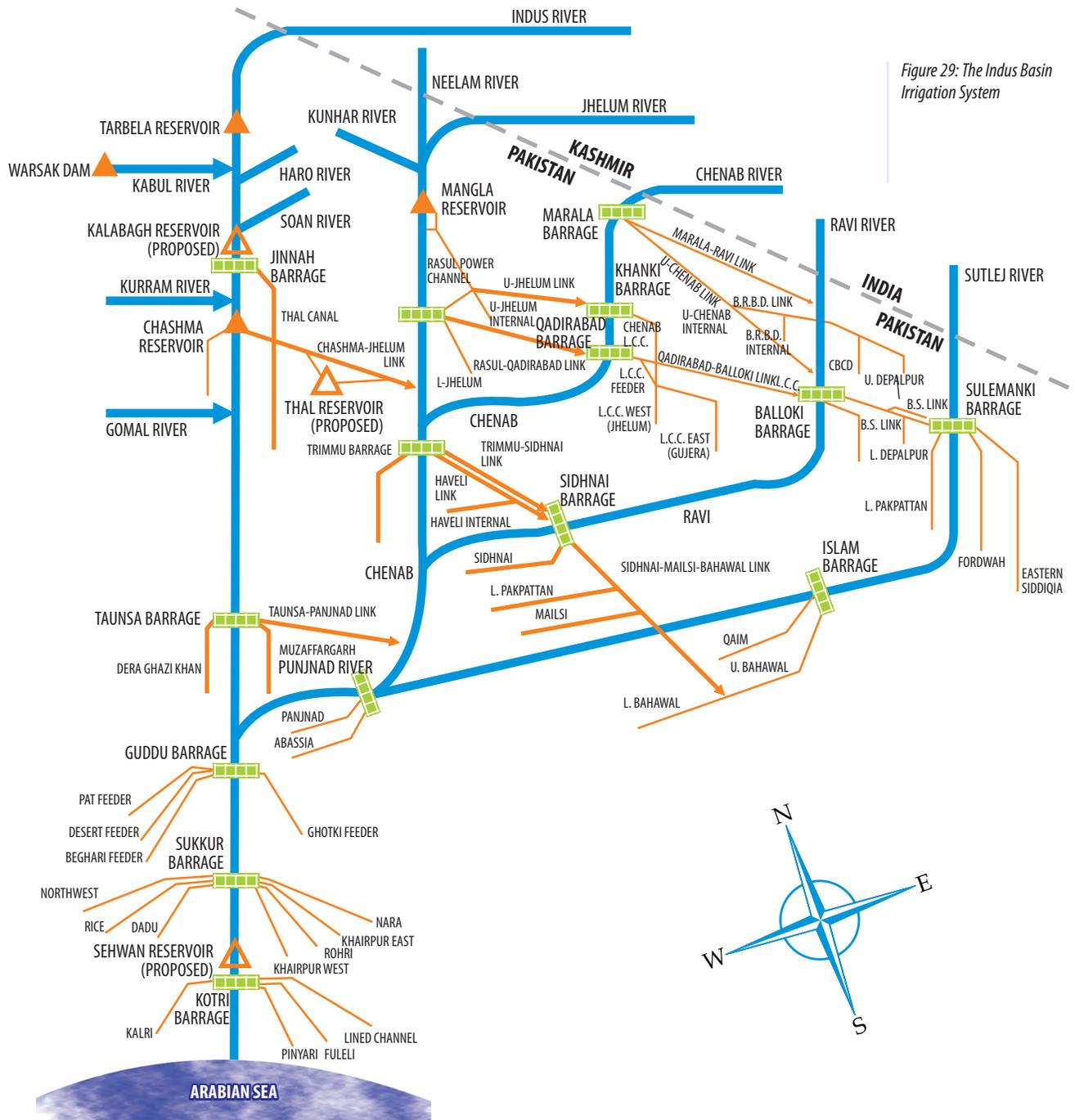
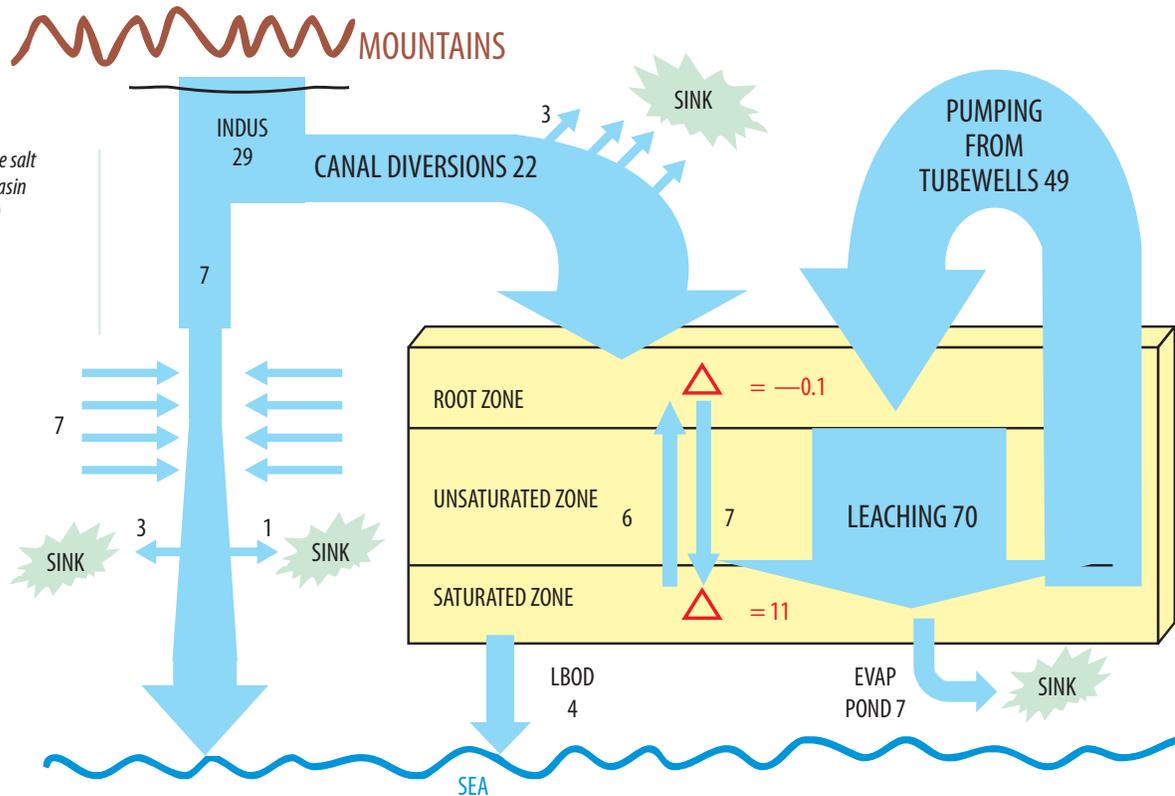


Figure 29: The Indus Basin Irrigation System

Figure 30: Approximate salt balance in the Indus Basin (million tonnes a year)



efforts to support a supply-driven model run aground and end up depending on the temporary beneficence of an external funder or financier. Most knowledge development must be driven primarily by a need to solve a problem. A virtuous cycle is established when users of knowledge become the most ardent advocates for generating knowledge and capacity.

- There is a tremendous amount to be learned from the experience of other countries.
 - the E-water experience in Australia (at a cost of \$100 million) provides an excellent example of how to approach the challenge of developing an integrated system in which user-focused products of a wide variety of types “fit together” and are mutually reinforcing.
 - The Australian example also ensures that academic work does not spin off into its own world but is instead tightly linked to providing answers to the practical problems of decision makers and operators. This develops a rich culture of “practitioners who think” and “thinkers who engage with practice” and in developing funding mechanisms, e.g. cooperative research centers in which institutions and disciplines to work together.
 - The Mississippi River Commission provides an excellent example of how a suite of decision support products ranging from rainfall and stream flow prediction, to geographic information systems that integrate land and water, to products that help local levee boards manage their infrastructure together provide a comprehensive system for managing floods.
 - The US Geological Survey provides an excellent example of how to ensure that knowledge products fit the specific needs of a wide range of users who then provide the political and financial continuity for maintaining and refining them.

- In all cases, over time the domination of engineering in water management so evident in Pakistan grows into a multi-disciplinary approach in which contributions from many fields (e.g. engineering, geology, geochemistry, meteorology, glaciology, limnology, ecology, economics, management, law and political science) to knowledge and practice become important and in which a generation of “specialized integrators” with firm grounding in a discipline, but with an ability to understand other perspectives and to integrate them becomes the most valuable human resource.

Annex 6 provides specific priorities for knowledge development. In all cases, the recommendations are consistent with the overall philosophy described above.

There are important roles for federal and provincial governments and for development partners in building the knowledge and capacity that Pakistan needs to manage this most precious of its natural and created resources. Some of the highest priorities are the following:

For the federal government:

- With partners like E-water or the US Army Corps of Engineers, develop a basic plan around which to build knowledge and capacity modules to meet the highest-priority challenges.
- In collaboration with agencies like WAPDA, the PIDs and the private sector, identify the highest priority areas for knowledge/capacity development. Engage universities and research institutions in partnerships with operators to develop first-generation products and practical and widely shared applications.
- With the Higher Education Commission in the lead and with active participation from key ministries and operating agencies in Pakistan and the cooperation of relevant agencies in other countries, re-assess and re-structure the water activities funded by the commission and others including the focus of Pakistan’s large Fulbright program.
- With PARC in the lead and with the active participation of key ministries and federal and provincial research institutions engaged in water, energy and productivity, prioritize research agendas in line with the action plans for water productivity, watershed management, small dams operations, developing command areas and spate irrigation, and forward and backward linkages including the marketing and value chains.
- With the Infrastructure Project Development Facility in the lead but with active participation of public health engineering departments (PHED) and water and sanitation authorities (WASA), and private sector housing authorities engaged in water supply and sanitation, conduct diagnostic studies and develop local action plans for the WASA and PHED along with knowledge support for the design and implementation of both regulatory frameworks and new contracts for providing urban water and sewerage services.

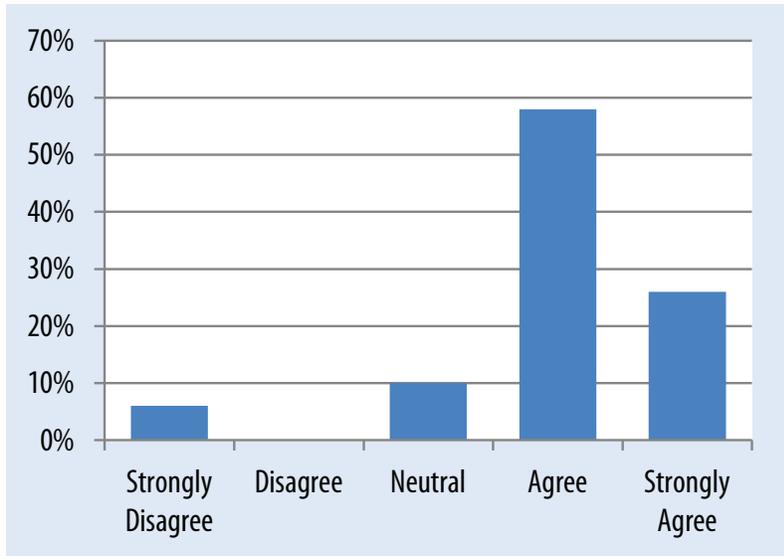
For the development partners:

- Facilitate the access of the Government of Pakistan to the best knowledge and capacity efforts through appropriate twinning rather than one-off consultancies.
- Support long-term partnerships between consortia of Pakistani and foreign “smart operating agencies” and universities to develop the knowledge, application tools, and capabilities that Pakistan needs in this vital area.

The recommendations regarding knowledge management are shown in Table 11:

Table 11: The Action Plan for Knowledge Management

No.	Action/Project	Objective	Primary Responsibility	Time Line	Indicative Financing (\$million)
5. KNOWLEDGE MANAGEMENT					
5.1	Partnership with an institution (like E-Water) to develop the architecture and culture which produces integrated, demand driven knowledge product	A consistent knowledge base for operations at different levels	MOWP, FFC, IRSA, WAPDA, PIDs	2012-2016	\$30
5.2	An operational simulation model for the Indus Basin	Management and investment decisions	WAPDA with PIDs	2012-2016	\$20
5.3	Knowledgebase for Groundwater management	Sustainability and productivity	MOWP, PIDs, FATA, SUPARCO	2012-2016	\$20
5.4	Other decision support systems for data sharing, canal, assets management and managing climate change	Operation of the 1991 Indus Water Accord and infrastructure, improved water productivity	PMD, IRSA, WAPDA, SUPARCO, PIDs and PIDs	2012-2016	\$30
5.5	Capacity building for management and research	Developing capacity	Higher Education Commission (HEC), MOWP, Ministry of Science and Technology, Standing committees of the National Assembly and Senate on water and energy, Universities and research institutions	2012-2016	\$15



Above - Figure 31: Stakeholders' assessment of the value of the diagnosis and recommendations of the WSTF Report: The knowledge base

The December stakeholders' consultation discussed the diagnosis and recommendations on the knowledge base in considerable detail. The views of the stakeholders on this section of the report are shown in Figure 31.

IV

IMPLEMENTING THE RECOMMENDATIONS

In its third meeting, the WTSF steering committee discussed the question of follow up and what it means to “implement the recommendations of the WSTF.” It was recognized that the role of the WSTF report is not to add another layer of accountability, but rather to help stimulate and galvanize actions that will materialize through well-established, permanent decision-making mechanisms.

Within the federal and provincial governments, the WSTF will provide inputs into the regular governmental functions, including the Five-Year Plan and budgeting. With external partners, too, there are well-established mechanisms (such as the Country Partnership Strategies with the development banks) for consultations. The WSTF will be valuable if it helps provide a road-map that influences these processes.

There are, however, some perceived shortcomings in the national capacity for thinking strategically and operationally about the future of water in Pakistan and for learning the lessons of experience and applying them to the water development and management processes. There has been some discussion about creating a national water commission in Pakistan, but not, as yet, much thought about how such a commission might be structured, what its mandate might be, and what it might achieve. The WSTF has looked at this question from the perspective of international experience.

A first observation is that standard exercises like proclaiming national water policies are ignored by most sophisticated countries and usually end up as a set of platitudes about equality, sustainability, and development that have little or no impact on what is actually done. A recent observation by the former Governor of the State Bank of Pakistan is an example: “Pakistan is full of beautifully written policy papers that are pious documents that nobody reads. We all agree on the substance of policy, but implementation is the real issue.”

A second observation is that some countries like Pakistan that face grave water challenges have found more action-oriented mechanisms for addressing the issue of setting a national direction and working toward it. An excellent example of this is Australia’s National Water Initiative (NWI) and the associated National Water Commission. The NWI is an intergovernmental agreement signed in 2004 between the federal and state governments to improve the management of the nation’s water resources and to provide greater certainty for future investment. The NWI is not a generic statement of intentions; rather, it details six specific action issues that were identified as the highest priorities in the short and medium terms. They are (i) to prepare water plans with provision for the environment, (ii) to deal with over-allocated or stressed water systems, (iii) to introduce registers of water rights and standards for water accounting, (iv) to expand the trade in water, (v) to improve pricing for water storage and delivery, and (vi) to meet and manage urban

water demands. An integral part of the NWI was establishing the National Water Commission as an independent, statutory body to audit compliance with the agreement. The commission comprises seven commissioners and provides advice to federal and state governments on critical water issues in addition to reporting on the progress of implementing the NWI.

Of course no institutional arrangement can be simply transplanted from one country to another, but an approach of this sort would appear to be appropriate for Pakistan. Discussions with members of the steering committee and stakeholders showed some enthusiasm for this idea, but there were two competing proposals for implementation.

The first alternative takes particular note of the fact that institutional capacity is limited and that further dilution is undesirable. The suggestion is that a national water commission could be part of either the FFC or IRSA or the Office of the Chief Engineering Advisor (who also serves as the chairman of the FFC). The WSTF has considerable sympathy for the underlying concern but also notes that the arms-length auditing function that would be the essence of the commission could not credibly be merged into institutions like the FFC and IRSA. The second alternative is to create a small, independent commission that would focus only on the items identified in a national water initiative and would report to the CCI.

The WSTF recommends that the Government of Pakistan conduct a review of similar efforts in other countries and develop an initiative tailored to the challenges that face Pakistan. The FODP could help conduct such a review and could facilitate visits by Pakistani federal and provincial officials to see how such institutions operate in practice. If Pakistan were to decide to move forward with such an initiative, a partnership arrangement with, say, the Australian National Water Commission might be explored.

In summary, the WSTF recommends that the federal and provincial governments consider launching a National Water Initiative (which would draw, inter alia, on the results of the WSTF) and the creation of a small, independent National Water Commission which would monitor the implementation of the NWI and report annually to the CCI.

Finally, some stakeholders asked that the WSTF report include specific recommendations for FODP financing as part of the report. It was explained that this was not the function of the WSTF. It would, however, be a logical next step for the Government of Pakistan to develop a financial plan with associated commitments with members of the FODP and other partners to implement the recommendations of the task force.

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MAJOR INFRASTRUCTURE

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a2

AGRICULTURAL PRODUCTIVITY

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The last two decades bear witness to Pakistan's vulnerability to floods. Pakistan's

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systematically

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The last two decades bear witness to Pakistan's vulnerability to floods. Pakistan's

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MAJOR INFRASTRUCTURE

Pakistan is, to a large degree, an arid country built around a single river. It is naturally an environment of extremes with large seasonal variations (with about 70% of the flow in the upper Indus occurring in just 3 months of the year) and large annual variations. Deserts with rivers flowing through them have long exercised a great pull on civilizations because they offer huge opportunities for prosperity if the extremes of river flows can be managed.

The requirement for major storage in the Indus Basin has been clear since the founding of Pakistan.¹ As our main report points out, two key technical elements are that (i) because of heavy sediment loads in rivers coming off the young Himalayas, live storage at existing dams will be steadily reduced over time and (ii) the additional yield (in terms of assured usable flows) would be such that every additional million acre feet (MAF) of storage creates an annual yield of 1 MAF. Accordingly, a new reservoir the size of Tarbela should have been built every decade since the 1960s. A second perspective was that hydropower could produce large quantities of clean, renewable energy at low cost. Again, the expectation was that Pakistan would follow rich countries that had substantial hydropower potential and had developed at least 70% of it.

Visionary leaders have long understood that there were not only large, direct benefits from such investments, but that the indirect benefits (supplying inputs for production and processing outputs) were also large. Despite these clear benefits, 50 years later only two minor additions have been made: some additional hydropower generating capacity at Ghazi Barotha, taking advantage of the regulating capacity of Tarbela, and the recent raising of Mangla Dam.

This annex describes the water storage and delivery system in Pakistan and its managing institutions and examines in some detail the institutional hindrances and financial dimensions that have slowed development of the system. In addition, the current objectives of the government and opportunities and requirements for getting momentum back for developing major infrastructure are outlined.

Background and Situation Analysis

Major Infrastructure Components and Capacity

Primary Water Storage, Hydropower, and Irrigation Systems

The Indus River Basin supports the largest contiguous irrigation system in the world. Its headwaters begin near the intersection of some of the highest mountains anywhere—the Himala-

1. Background papers are available from the Asian Development Bank on “The Economics of Large Infrastructure in Pakistan” and “Hydropower.”

yas, Karakoram, and Hindu Kush ranges. The snowmelt and monsoon rains that fall in these northern mountains flow down through very arid and flat lands (as the elevation slope towards the Arabian Sea from the beginning of the plains in the north to Karachi is just 1,000 feet). This affords great potential for extensive irrigation and hydropower, but the infrastructure requirements are large and need complex investment to yield sufficient benefits. The outputs from this system—water for irrigation and hydropower—are some of the most critical components of future economic development in Pakistan.

The reservoirs are Tarbela, Mangla, and Chasma with 6.78, 4.46, and 0.22 MAF live storage capacities respectively.² In rich countries with rivers flowing through arid landscapes, large dams provide much more storage capacity. The Colorado River in the United States and the Murray Darling River in Australia, for example, supply reservoirs with the capacity to store about 1,000 days of average flow versus the 36 days of storage in Pakistan’s three main reservoirs.

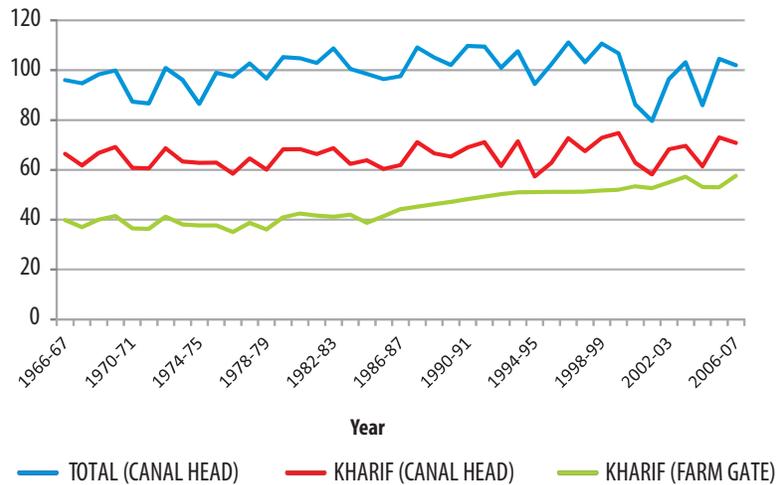
In Pakistan, 16 barrages (structures which divert but do not store water) distribute water into 44 canals with an average length of 1,274 kilometers (km). Numerous smaller distribution structures—watercourses and other secondary canals—take water from the main canals to farmers’ fields that cover nearly 27 million acres. Additionally, the reservoirs provide hydroelectric power and flood protection. It is the peak of a flood that causes most damage, so reservoirs have a mitigating effect if volume is available to store flood peaks. During 2010, the Tarbela Dam had a positive effect on the flood peak (see Annex 4). Additionally, some planned dams will have volumes available for flood management.

The extensiveness (and limits) of the system in Pakistan are captured in the following statistics:

Major reservoirs:	3 (11.46 MAF storage)
Barrages:	16
Head works:	2
Inter link canals:	12
Canal systems:	44 (average length: 1,275 km)
Watercourses:	107,000 (Average Length: 15 km)
Hydropower capacity:	6,536 megawatts (MW)
Potential capacity:	59,208 MW
Irrigated area:	27 million acres
Potential irrigated acres	47.3 million acres

2. Values from the Water and Power Development Authority to Water Sector Task Force in October 2011. The Mangla Dam raising project has added 3.1 MAF, but it has not been filled and so is not considered live storage.

Figure A1.1: Annual Water Supplies Total and Kharif Season 1966–2007
 Source: National Agro-Ecological Resources Database (NARD) Version 1.0, Natural Resources Division, Pakistan Agricultural Research Council



It is plainly evident from the last figures that the installed capacity for hydropower and actual irrigated acres are far below the estimated potential. A key part of this deficiency is that the irrigation system is now unsustainable financially. Maintenance is only rarely undertaken often using loans from donor agencies. This state of affairs can be expressed as “build-neglect-rebuild.” The abiana (water user fee) is set much lower than cost of operation and maintenance, and yet recovery is less than 50% in the three provinces served by the system, and it is around 10% in Baluchistan. How to increase recovery of abiana is a major challenge in all the provinces.

Water Supply and Demand

Seasonal, annual, and daily river flows in the Indus River system are highly variable, so with limited storage, the ability to regulate flows is severely limited.³ River flows are typically limited in winter (rabi) because of limited glacier and snow melt and low rainfall. The western rivers provide 136.1 MAF of surface water in an average year (50% probability). The bulk of the river flow is during the summer (kharif) season—five times the flow of the rabi season—and yet most of the deficit in supplies for crop water requirements occurs then. With eastern rivers contributing 7.0 MAF of water on average, the mean annual flows are 143.1 MAF at rim stations.

Figure A1.1 shows the variability in total water supplies at the canal head along with the higher use during summer where both canal head and farm gate supplies are shown. The average supplies are flat, as would be expected, with little trend, but they are variable. The exception is the drought, when total supplies dropped from 110 MAF to about 80 MAF in just 3 years. The typical variation is about 7.5% around the average, and somewhat less in summer at 7.0% (when most of the water flows), but the variation compared to the average rises to 15% at farm gate.

It is the maximum and minimum variations that constitute major challenges for a storage system, so the onset of the drought led to a 30 MAF decline over 3 years. The anticipated growth in storage has little chance of smoothing this out much, but directing several MAF to the most affected areas could reduce the probability of crop failures. The one trend that is noticeable in the graph is the increase in farm gate supplies suggesting some improvement in watercourse and second-

3. Ahmad, S. 1999. *Achievements and Issues of Irrigation in the 20th Century: Proceedings of the National Workshop on Water Resources Achievements and Issues in the 20th Century and Challenge of the Next Millennium*. Islamabad. PCRWR/UNESCO, 28-30 June 1999, p. 188-201.

ary canal delivery over time so that losses appear to have declined. Nearly 90% of the demand for water comes from agriculture for crop water requirements (CWR). These CWR are affected by temperature, soil moisture, wind, and a whole set of related variables. They are naturally highest in the summer at the time that the supplies are the greatest; however, based on surface water supplies, an example from Punjab⁴ demonstrates that deficits relative to needs are 25.8 MAF in rabi and 57.5 MAF in kharif, which has been made up by groundwater use.

Flows into the Arabian Sea

The 1991 Water Accord recognized that flows were needed for maintaining mangroves and fisheries in the delta and for limiting saline intrusion. The accord indicated that the issue would be addressed once a conclusive study on what flows were required was completed which was done and reviewed in 2005. This internationally-reviewed study concluded that the flows need to be about 8.6 MAF/year through the delta to support environmental requirements. This flow is divided between a continuous flow of 5000 cubic feet per second (about 3.6 MAF over a year) and other, irregular flushing floods to move sediment to the delta. The needed occasional flows are 25 MAF over a 5-year period. In an average year, the need for extra storage release to meet these flow requirements is 1.26 MAF.⁵

Anticipated Impacts of Climate Change

It is estimated that about 45% of the flow of the Indus comes from snow and glacial melt (and the rest from rainfall). Changes in the behavior of the glaciers, in rates of melting and in the type, duration and location of precipitation will all influence flows in the river system. That said, there is enormous uncertainty about all of these factors, and wildly-different predictions about their effects on the Indus. What does seem certain is that the future will be different from the past, and that managers of the water system need to develop both infrastructure and institutions which are resilient to changes in flows.

With these (very important) caveats, it would appear that the main pattern of change in river flow will be a gradual increase in volume in the melting season (May to September). Based on the most recent Intergovernmental Panel on Climate Change climate scenario and information on glacier areas and volumes in the Indus River Basin, a calculation done by the Water Sector Task Force (WSTF) on the magnitude of inflow into the Tarbela Reservoir during a dry and a wet year is shown in Figure A1.2.

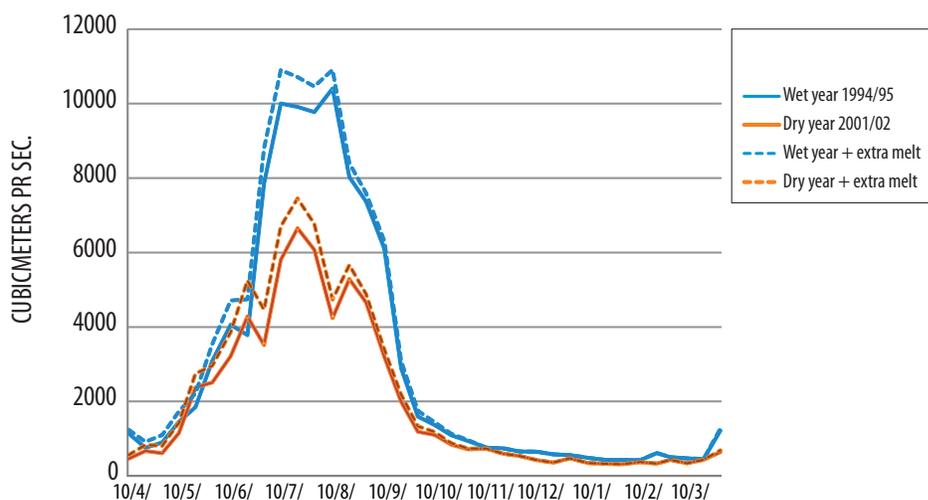


Figure A1.2: Indus Inflow into Tarbela Reservoir in Wet and Dry Years
Source: Water Sector Task Force calculations

4. Pakistan Ministry of Water and Power. *Enhancing Land and Water Productivities through Use of Resource Conservation Technologies and Rationalization of Cropping Patterns. Project Management and Policy Implementation Unit, Policy Study 1, Final Report by AAB (Pvt.) Ltd. Islamabad. March 31, 2010.*

5. *Final report of the independent panel of experts reviewing studies on water escape below Kotri Barrage. October 2005.*

An increase of 5%–15% in monthly mean flow seems likely from the extra glacier melt alone. Other factors influencing flow volume may be evaporation and changes in snow melt from mountains outside the glacier areas and changes in precipitation patterns.

Hydropower Supply and Demand

The installed capacity for hydropower electricity generation is 6,536 MW, all of which is under WAPDA control. As shown in Table A1.1, this represents about one third of the total electricity generating capacity in the country (and accounts for 35% of the wattage generated). Largely due to shortages of affordable oil and gas, the dependable capacity is lower for thermal units, and due to lower water flows in the winter, the dependable capacity from hydropower is lower during that season. Nonetheless, the shortages appear to be smaller in the winter, and with better water flows, some of the shortages could be covered by existing capacity. (These added flows could best come with greater storage, such as from Diamer Basha, permitting larger off-season water flows.)

Table A1.1: Existing Installed Electricity Generation Capacity⁶

Type of Generation	Installed Capacity (MW)	Derated Dependable Capacity (MW)	Availability (MW)	
			Summer	Winter
WAPDA Hydro	6516	6516	6516	2300*
GENCOs	4764	3580	2200	3222**
IPPs	9085	8295	7600	6900**
Rental	393	393	200	83***
Total	20758	18784	16516	12505
Maximum Electricity Shortages		Summer 6151MW	Winter 2469MW	

*Hydro availability based on last five years average ; **Excludes 10% forced outages for GENCOs and 6% for IPPs and Rental; ***83MW Rental Plants in operation, remaining under testing.

In 2010 and 2011, load shedding was as high as 5,000 MW, or about 25 % of total demand. This has caused social and political unrest in Pakistan fed by continuous negative commentary from the media. It also expected that demand for electricity will grow by 5% to 7% per year, and there may be constraints to growth of thermal capacity from import limits on fuel and perhaps low interest from private providers, so hydropower expansion will likely be needed to meet much of the growth in demand.

Hydropower production is primarily divided into two categories: production from storage reservoirs and production from “run of the river” (ROR) schemes. Production from storage reservoirs is independent of day-to-day water flow in the river by extracting water from the reservoir in periods when the inflow is low and storing water when the inflow is high. The production capacity will depend both on the water level in the reservoir and the extracted water volume (see the example from Tarbela in Figure A1.3). Examples of storage production power stations in Pakistan are Tarbela and Mangla.

ROR power stations have to rely on daily or even hourly flows in the river and most often will have a smaller intake reservoir to dampen short-term inflow variations and to avoid direct sediment impacts on the gates and power machinery. The best combination of storage and ROR power stations is to have the storage in the upper part of the river basin and ROR stations further downstream. An example combination is the Tarbela Dam and the Ghazi Barotha power station.

6. Government of Pakistan, Water and Power Development Authority. *Hydropower Brochure*. November 2011, p. 69.

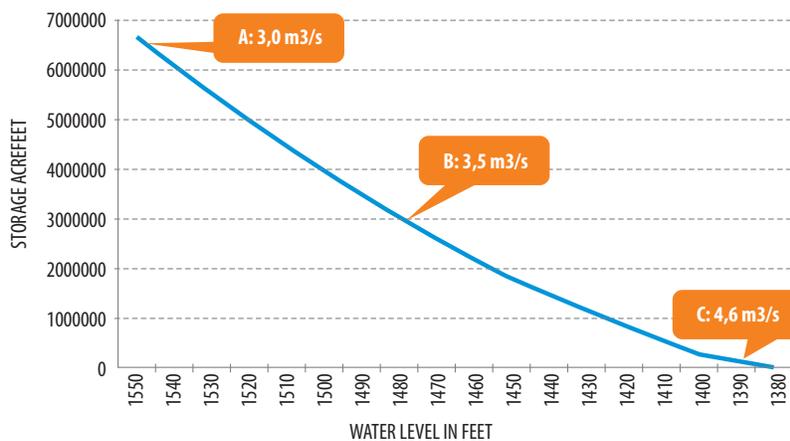


Figure A1. 3: Water Levels and Volumes Needed to Produce 1 Megawatt of Electricity at Tarbela Dam
Source: WAPDA, Tarbela Power Station Engineering Department

Current Policies and Limitations

For decades, a combination of internal dissension and external prevarication precluded the building of new large dams. Mistrust was greatly exacerbated by decades of opacity in measuring water delivered to provinces, the distribution of profits from hydropower, and sharing benefits with local people. The combination was paralyzing, and the Council of Common Interests (CCI), the constitutional body for addressing federal-province issues, was, until recently, able to agree on building the new dams which are so vital for Pakistan.

Water Accord and “Irrigation-First” Policy

The Water Accord was signed in 1991, mainly based on the actual canal diversions from 1978 to 1982. Some political adjustments have been made such as excluding the two smaller provinces Khyber Pakhtunkhwa (KP) and Baluchistan 8% share) from shortage sharing. The Indus River System Authority (IRSA) was created as part of the accord and manages the distribution of irrigation water among provinces. The accord specifies that the primary purpose of water management in dams is to support irrigation needs, a point made continually in meetings with officials during this project.

The general problem with this approach is that turbines are designed to produce optimum electricity based on a combination of pressure and discharge with possible substitutions of one for the other. Thus, with higher levels in a reservoir and higher pressure, smaller discharges generate more electricity. Maximizing this output may reduce irrigation benefits because to increase electricity generation, water might be retained in the dam when needed for irrigation. Thus, costs and benefits of different operational rules should be part of any approach taken for new infrastructure, subject to keeping as much of the accord in place as possible. (Flood prevention is a third issue. See Annex 4).

The Accord defines three distribution patterns for allocating water among the provinces; allocations when shortages and surpluses occur are quite different. Several ambiguities exist in what constitutes “initial conditions” that have created mistrust in the process. Also, the method for estimating water availability depends on prior irrigation season deliveries, and each province presents its own “estimates” that naturally align with its interests. Without accurate measurements, issues like where the 20 MAF of water “lost” in conveyance between barrages and canal head works has gone cannot be resolved.

Policies on Sharing Benefits of Hydroelectric Power⁷

A number of constitutional and other legislative policies form the basis for sharing the benefits of hydropower; articles 157, 161, the 2002 Power Policy, Land Acquisition Principles, and the 18th amendment are the most important. For this discussion, the benefit sharing mechanism in Article 161 of the Constitution of Pakistan is critical. It states that, “The net profits earned by the Federal Government, or any undertaking established or administered by the Federal Government from the bulk generation of power at a hydro-electric station shall be paid to the Province in which the hydro-electric station is situated.” According to the Water Sector Capacity Building and Advisory Services Project (WCAP) report Benefit Sharing in Hydropower Projects, “net profits” are calculated by, “. . .deducting from the revenues accruing from the bulk supply of power from the bus-bars of a hydro-electric station at a rate to be determined by the Council of Common Interests, the operating expenses of the station, that shall include any sums payable as taxes, duties, interest or return on investment, and depreciations and element of Benefit Sharing over-heads, and provisions for reserves.”

The problems with these policies are several. First, the calculation of “net profits” has been the subject of attempts at revisions and has created an enduring dispute between WAPDA and KP on amounts due. Second the benefits do not necessarily go to those provinces and communities which are directly affected by the construction of the reservoir. These factors have created mistrust among the provinces and played a major role in the long hiatus in developing the major infrastructure so critically needed in Pakistan.

Collecting Abiana and Charges for Hydropower Revenue

As mentioned previously, the recovery of abiana is less than 50% in Punjab, KP, and Sindh, (and it is only 10% in Baluchistan) and the actual amounts are hardly a fraction of the full cost of operating and maintaining the water system. The costs of collection exceed returns as well. Given that this issue has been ongoing for many years, the WSTF believes that unbundling the system and writing contracts at points where water can be measured and regulated needs to be tried. (Figure 16 in the main report portrays a typical canal command in the Indus Basin). Most importantly, services need to improve before rates increase.

Currently, electricity tariffs for WAPDA have two tiers with the first for electricity generated from capacity that has been paid for such as Tarbela and Mangla. At present, including fixed and variable portions, this is about 63 paisa per kilowatt hour (Kwh), but WAPDA has asked for an increase to Pakistan rupees (PRs) 1.43 (which appears to be close to operating costs). On new infrastructure, WAPDA makes proposals to the National Electric Power Regulatory Authority (NEPRA) for tariffs that cover costs for operations and maintenance, depreciation, return on equity, and added amounts to finance later projects. These are currently around PRs4. Figure A1.4 shows the growing negative gap between the cost of electricity service and the retail price paid by consumers.⁸ The costs of electricity are about PRs8.8 (or \$0.11) in the graph while the average charges are much closer to PRs 6.0. The peak charge during which hydroelectric power will be most used is about PRs 12.25 or \$0.14. (NEPRA has announced a hearing to review even higher charges of up to PRs 18.60).

7. Sections on benefit sharing are taken from the report by AAB (Pvt.) Ltd. Islamabad, July 2011: *Studies and Policies for Benefit Sharing on Hydropower Projects among Stakeholders: A Study for WCAP. Pakistan Ministry of Water and Power, Islamabad.*

8. *Friends of Democratic Pakistan: Energy Sector Task Force Report. 2010, page 10.*

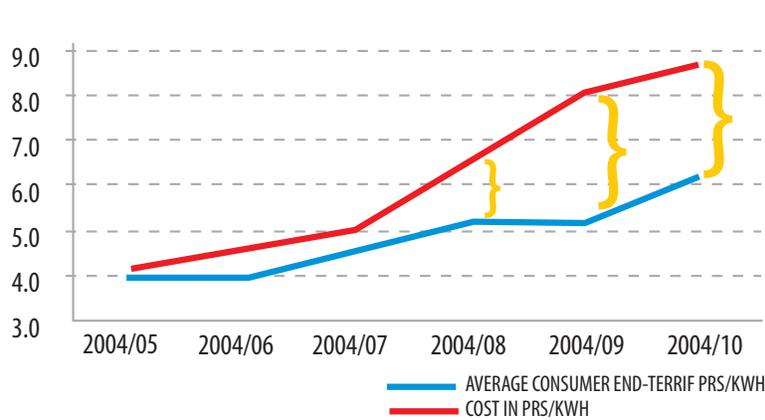


Figure A1.4: Gap between Electricity Cost and Retail Price
Source: Pakistan Electric Power Company (PEPCO) Data

Key Institutions

The two most important federal institutions managing large infrastructure are WAPDA and IRSA. Additionally, the provinces are responsible for barrages and canals within their boundaries and interact with IRSA to make forecasts and determine water needs. They also are responsible for working with affected communities when infrastructure projects are in their regions. The Federal Flood Commission (FFC) has a mandate to ensure management of floods and flood protection works and is also responsible for formulating a national flood protection plan, including structural and non-structural elements, and its implementation in the provinces. The FFC and other flood control issues are addressed in Annex 4.

In addition, the Private Power Infrastructure Board provides help to private investors in the energy sector. For several years there have been political efforts to involve the private sector in new hydropower schemes, but outcomes have been very limited.⁹ In this section, we therefore focus on WAPDA and IRSA.

WAPDA

Created in 1958, this organization is the federal authority under the Ministry of Water and Power for planning and building large infrastructure in the water sector. The WAPDA web page states that “The Charter of Duties for WAPDA is to investigate, plan and execute schemes for: Generation, transmission and distribution of power; Irrigation, water supply and drainage; Prevention of water logging and reclamation of waterlogged and saline land; Flood management; Inland navigation.” Effectively WAPDA has the responsibility for developing, planning, and overseeing the construction of major infrastructure in the country. For some categories such as barrages, they turn ownership over to the provinces but may continue to manage them.

IRSA

IRSA’s main task is to distribute irrigation water among provinces in line with the Water Accord of 1991. As noted, the accord specifies that the primary purpose of water management in dams is to support irrigation. IRSA does not have responsibility for developing major infrastructure. The five members of the authority represent the federal government and each of the provinces. Meetings are held at the beginning of kharif and rabi with an advisory committee, and forecasts are made to determine releases based on last season’s reservoir levels, cropping

9. Friends of Democratic Pakistan Energy Sector Task Force Report. 2010, pages 103–108. List from WAPDA August 2011. Brochures published on the WAPDA web pages. Information from WAPDA officials in meetings on 10 and 12 August 2011.

patterns, and other agronomic indicators. These forecasts are adjusted in consultation with the provinces and WAPDA, but IRSA must make sure that releases are consistent with the proportions allotted to each province. IRSA requests water releases from WAPDA every 10 days to make sure that irrigation needs are filled as well as possible given storage availability and CWR.

Table A1.2: Hydropower Projects with High Priority

No.	Project	River	Location	Capacity (MW)	Storage (MAF) gross/live	Est. cost (US\$ million)	Earliest initiation	Tentative Project Commissioning
1	Diamer Basha	Indus	GB	4500	8.1/6.4	11178	2011	2020
2	Kurram Tangi	Kurram	FATA/KP	84	1.2/0.9	700	2011	2015
3	Golen Gol	Chitral	KP	106	ROR	130	2011	2015
4	Tarbela 4th Ext.	Indus	KP	960		826	2011	2015
5	Munda	Swat	FATA/KP	740	1.3/0.7	1401	2012	2018
6	Kohala	Jhelum	AJK	1100	ROR	2155	2012	2018
7	Bunji	Indus	GB	7100	ROR	6830	2015	2023
8	Dasu	Indus	KP	4320	1.15/0.9	5206	2013	2027
Total				18910	11.75/8.9	28426		

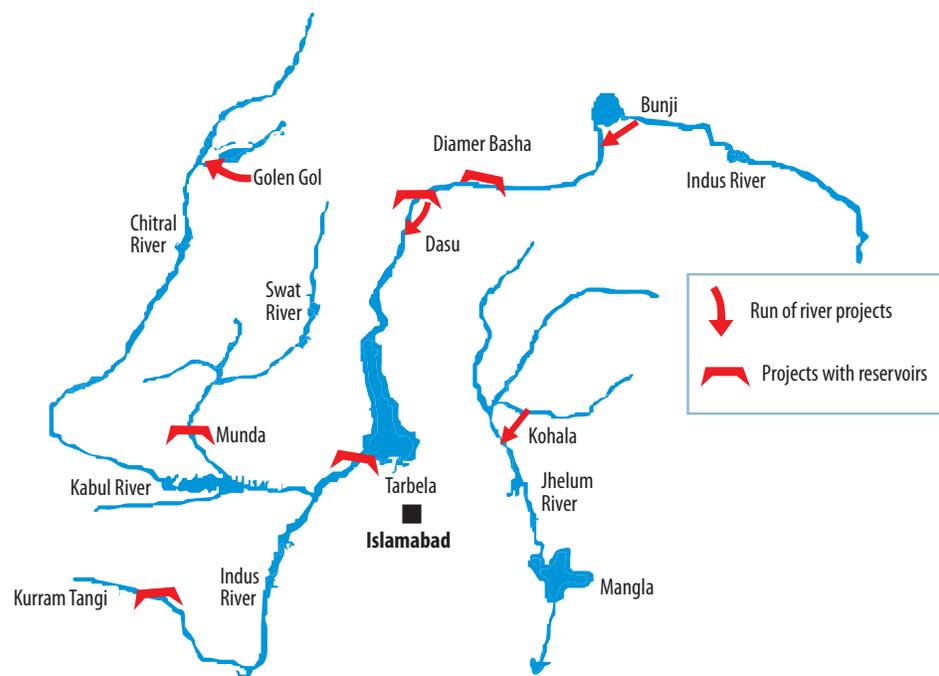
Source: WAPDA August 2011 list: Note: AJK= Azad Kashmir, FATA= Federally Administered Tribal Areas, GB= Gilgit-Baltistan

WAPDA Priority Plan for Dams and Hydropower Stations

A central element in the Liefertink Report in the 1970s was that Tarbela and Mangla were just first steps to increase the proportion of Indus Basin water controlled in reservoirs and the production of hydroelectricity. WAPDA and the government revised the infrastructure development program and disseminated it in a plan named Vision 2025. In this plan, eight projects had the highest priority in the short term (Figure A1.5 and Table A1.2).²

Each project in Table A1.2 will add capacity to address flood control, electricity generation from hydropower, and storage for irrigation. These priorities together form a balanced port-

Figure A1.5: Hydropower Projects with High Priority.
Source: WAPDA August 2011 list



folio that takes important steps in each direction. Some projects, including Golan Gol on the Chitral River, Kohala on the Jhelum River, and Bunji and Patan on the Indus River, are ROR projects that focus exclusively on hydropower. The Tarbela fourth extension is also a dedicated hydropower project; together they could provide about 19,300 MW of new capacity, thereby raising total electrical capacity in Pakistan by 70%. With continued growth of 5% to 7% per year, the demand for electricity will double in less than 15 years. This added hydropower capacity will contribute significantly to reducing current and future deficits.

Munda and Kurram Tangi dams are both on the western tributaries of the Indus River where much of the flood damage in 2010 originated. Had this infrastructure been in place, the costs of that flood would have been greatly reduced. These dams will provide some storage, but that is likely to be used for flood control rather than as storage for irrigation. It is expected that in the Munda Reservoir, 0.24 MAF will be dedicated to flood storage or about one third of the total live storage.¹⁰

That leaves the main sources of added storage for agriculture with the Dasu and, especially, Diamer Basha dams. The small amount of storage that currently exists has been reduced through continued sedimentation which, as is well known, could be slowed by the presence of Basha that will be upstream of Tarbela. It appears that the environmental aspects of these projects are manageable with the Diamer Basha project being the most challenging.

Diagnosis

This section has two main parts: one identifies challenges in developing major infrastructure and the other assesses opportunities. The challenges relate to storage and irrigation, hydropower, and institutional impediments. The section on opportunities starts with a detailed discussion of the economic benefits of increased water and electricity, discusses other benefits from electricity generation and storage, and finally reviews institutional opportunities.

Challenges

Storage and Irrigation

Annual flows and variations were presented earlier at an average of 143 MAF during a typical year. The irrigation deficits relative to surface flows were recently estimated as 57.5 MAF in kharif and 25.8 in rabi, are large relative to total storage of 14.39 MAF. Also, water volume reaching canal heads dropped by nearly 30 MAF during the recent drought. The anticipated increases will raise total days of storage to 51 from 36 which will be sufficient to cover about 35% of the water deficit in rabi or 30% of the decline during the recent drought.

Sedimentation and climate change. As noted in the first section, gross storage has been reduced by 20% in Mangla due to inflowing sediment. The recent raising of Mangla has substantially increased its lifetime. Tarbela Dam lost 33% of its gross storage, but the completion of Diamer Basha Dam will lengthen its life by 35 years. Among new infrastructure, special attention must be given to hydropower projects high upstream in the Indus River that are closer to the glaciers that produce much of the fresh sediment from eroding bedrock under the moving ice. For the Bunji project, a long series of sediment measurements exists. The average annual transport of 87 million tons is very large but there are large inter-annual variations.

10. Asian Development Bank. 2010. "Pakistan 2010 flood – a snapshot."

Two major problems are connected with this large sediment volume: a) the intake reservoir will need a proper flushing system, and b) an operational plan is required to minimize the erosive sediments passing through the turbines. In Bunji, it is proposed to select an intake reservoir with a proper flushing system that needs about 200 hours to flush the accumulated sediment past the dam. The concentration of sediment in the water passing the turbine will still be high, but is estimated to be lower than the critical level where abrasion on the turbines becomes damaging.

An increase of 5% to 15% in monthly flow seems likely from extra glacier melt due to climate change which is an increase of 7–10 MAF per year concentrated in the melting season (May to September). Clearly, this adds stress on the system as this is the precise time when reservoirs fill, so they could fill faster and lead to less storage for flood control (but to more electricity with higher average reservoir levels). In order to capture the increasing need for storage which will far exceed the 8.9 MAF added in the current projects, other major projects will ultimately need to be considered. Because of the time to completion, it is unlikely that overbuilding will occur, and additions will be useful even after the higher flows from climate change have passed as there will be less than 50 days of storage at that point and demand will still easily exceed that capacity.

Flood control. Along the main Indus River, only the Tarbela Reservoir today has an active role as a physical flood control tool. One ideal use of the reservoir is to mitigate flood peaks when most damage on infrastructure is done. This was well illustrated in the analysis of the 2010 flood. At the maximum flood peak, 23,380 cubic meters (m³)/second (s) (835,000 cubic feet/second [cfs]) flowed into the Tarbela Reservoir compared to a maximum outflow of 16,900 m³/s (604,000 cfs). The reservoir thus was able to cut down the flood peak by 6468 m³/s (231,000 cfs). This saved downstream river areas from even worse damage than they experienced. There is a clear need for more reservoirs to control flood peaks, both on the main Indus River and on some western rivers where no reservoirs exist today. (Munda Dam is the main option in the list of eight priority infrastructure projects for this benefit). Taking into account expected increasing inflow from glacier melt that will fill up Tarbela Reservoir earlier in the summer and the gradual filling of the reservoir with sediment, a large reservoir is needed upstream of Tarbela. The Diamer Basha Dam can meet this need.

The high and devastating costs from floods in the past two years have brought flood control into the forefront, but studies like the Tarbela Dam Study for the World Commission on Dams and background papers for the World Bank “Running Dry” report suggest relatively small benefits compared to other uses of storage, so the rather limited storage may not go to flood control.

Hydropower

The current electricity generation is about 92 terawatt hours (Twh) per year in Pakistan with 30% coming from hydropower. Demand statistics are not precise, but if growth is 5% (a low estimate) over the next several decades, demand will double in less than 15 years. The Friends of Democratic Pakistan (FODP) Energy Sector Task Force (ESTF) recently estimated that the costs of inaction in terms of imported oil could be \$38.2 billion in 5 years. Thus, proceeding with the priority infrastructure list in Table A1.2 is essential as with its completion 76 Twh will be added to annual electricity generation thereby covering over 80% of the energy needed over the medium term and offsetting a large part of the potential bill for oil imports.

While potential supplies of hydropower are large at 59,200 MW, the initial investment is high at about \$31.2 billion for the current list of medium-term priorities from WAPDA. These have been moving forward slowly because international investors and donors are skeptical that projects are financially viable, and they question the ability of WAPDA and others to meet current best practices in resettlement, compensation for affected communities, and environmental protection. The financial benefits can be seen easily in savings in oil imports, but the financial limitations are clear also in that both energy and water for irrigation, the primary outputs from added infrastructure, are underpriced by government regulations or lack of political will to ensure collections. Moreover, early experiences with the construction of Mangla and Tarbela were unsatisfactory in terms of compensating and handling affected communities. In short, most problems in hydropower are related to institutional impediments.

Institutional Impediments

Lack of Trust

Until very recently, dam construction has been met with great mistrust among stakeholders about the seriousness of government concerns for impacts on local communities. Poor outcomes from the Mangla and Tarbela dams in the past have led to negative reactions to proposed new dams as the provinces and affected people do not believe that the government will provide adequate benefits and compensation.

Recent experience has, however, shown that WAPDA and other agencies understand past deficiencies and are capable of moving toward best practices. During the recent raising of the Mangla Dam, for example, about 50,000 people had to be resettled. The cost was 51% of the total project budget.¹¹

The resettlement issue for the Tarbela Dam has still not been finalized, but WAPDA intends to settle the case in connection with the fourth extension of Tarbela power stations. Ghazi Barotha shows that WAPDA has had positive experiences in addressing the needs of affected communities and other stakeholders. These perspectives and practices are apparent in the work on Diamer Basha.

Water Accord

Good agreements are stable, predictable and flexible so voluntary mechanisms for adjustments over time can be developed. Because there are legitimate contending views from different parties, agreement on principles for inter-provincial water sharing is difficult everywhere. In this light, the 1991 Water Accord is a major achievement that neighboring countries have not been able to consummate. The accord defines three distribution patterns for allocating water among the provinces as shown in Table A1.3 below. It is an imaginative blend of the two principles governing trans-boundary waters. The principle of no appreciable harm is applied to prior uses, and the principle of equitable utilization is applied to both future water developments and periods of abundant water availability.

11. WAPDA, *Brochure of the Mangla Dam Raising Project*. Available at <http://www.wapda.gov.pk/pdf/ManglaR1010.pdf>

Table A1.3: Water Accord Allocations by Province and Paragraph

Comparison of Para 14(b), 2 and 4 (Percentages)			
Province	Para 14(b)	Para 2	Para 4
1	2	3	4
Punjab	53.1	48.9	37
Sindh	42.2	42.6	37
Balochistan	1.6	3.4	12
Khyber Pakhtunkhwa	3.0	5.1	14
Total	100.0	100.0	100

Source: Authors' Compilation from the 1991 Water Accord

Initial conditions. Several ambiguities in the 1991 accord, especially relating to what constitutes “initial conditions,” exist because allocations when shortages and surpluses occur are quite different. In the view of Punjab, paragraph 2 was contingent on building on additional storage, but absence that storage, it is paragraph 14b that defines the starting point. In the view of Sindh, it is paragraph 2 that constitutes the initial conditions. IRSA officials have shown maturity and seriousness in developing a modus operandi that works in practice, but it means that there is constant public arguing that exacerbates rather than reduces rhetoric and mistrust. This contributes to a false public perception that the water accord does not work.

The accord has been implemented for 20 years with a considerable degree of success as IRSA members have developed a formula for interpreting it that does work. The formula is to provide water depending on its availability in the river system as shown in Figure 3 in the main report. In the low-availability scenario, where water availability < actual average system uses 77–82, water is distributed as per 14 (b) of the accord. In the medium-availability scenario where water availability > actual average system uses 77–82 but < paragraph 2 of the accord, historic uses are protected (as per paragraph 14(b), with the balance distributed as per paragraph 2. In the high-availability scenario where water availability is great than paragraph 2 of the accord up to the limit defined in paragraph 2, the allocations are as per paragraph 2, and any excesses are distributed as per paragraph 4.

Estimating water availability. The method for estimating water availability is primitive as it, depends on correlations with prior irrigation season deliveries. IRSA sensibly adapts these estimates as the season goes; however, standard practice is that each province presents its own “estimates” which naturally accord with their specific interests. This leads to systematic accusations of manipulating forecasts that undermine trust in IRSA.

There are still major ongoing controversies over measuring flows at both the barrages and the heads of the canals that distribute water. These measurements are the responsibilities of the provinces. In principle, other provinces send officials to “check,” but this arrangement does not work. The telemetric system (which was supposed to automate this) has not worked effectively. Additionally, a robust system for data collection and analysis is needed to determine such issues like where the 20 MAF of water that is “lost” in conveyance between barrages and canal head works has gone. This number has doubled over the last decade although there have been no changes in flows or stream morphology. Prima facie evidence is that unauthorized abstractions are increasing rapidly. Thus there is an urgent need for an independent, techni-

cal assessment of these losses, for defining what true conveyance losses are, and for bringing illegal abstractions into the allocation and management system. One piece of good news is that Punjab has made a major step forward and has put its measurements at the head of each canal (and down the canal) on line and updates the data every fortnight.

Irrigation-first policy. The other issue related to the Water Accord is of course the policy and associated operational rules that put dam releases for irrigation as the first priority which results in losses with significant financial impacts.

Collecting Abiana

There is a long history of failed attempts to collect revenues for water in the irrigation system, and in fact there are also instances of politically reversing charges to electricity users. The infrastructure suggested has great potential to unleash economic value, but financing it will be a challenge.

Sharing Benefits

We have often noted the need for appropriate legislation, monetary compensation, and sharing benefits to support the eight proposed priority infrastructure projects. This will require new legislation and probably some new institutions, but it is essential for the country to attract international donors and to consider more ambitious projects.

Opportunities

For Primary Inputs into the Economy

Water and energy, the two resources affected significantly by major infrastructure choices, can be valued in several ways. First, it is necessary to value the main outputs (water and electricity) in order to determine whether the costs of the infrastructure are worth incurring. These values can be what is actually charged or the economic value of the resources. A second approach is to evaluate the support that key inputs like water and electricity provide to the general economy.

Alternative values for water and electricity. The PC-1 for Diemer Basha Dam used \$0.083 for benefits of water (per cubic meter) for irrigation and \$0.0694 per Kwh of electricity generated. A review of other studies and related calculations suggest that these are reasonable figures and so were used in the WSTF calculations. Some added perspectives on this value are warranted. Figure A1.4 showed a consistent negative gap between the cost of service for the producer and the retail price. The costs of electricity are about PRs8.8 (\$0.11) in the graph while the average charges are much closer to PRs 6.0. The peak charge when much of the hydroelectric power will be used is about PRs12.25 or \$0.14 (which is under review for increases of up to PRs18.6). While a higher price might be justified, we use the PC-1 value for consistency with previous analyses.

Accounting for indirect effects. A second view is that added energy and water from improved infrastructure unlocks greater economic activity. The starting point for assessing these effects is to examine multipliers to see the extent of direct and indirect effects. The authors developed a simplified input-output matrix from the International Food Policy Research Institute 2004 Social Accounting Matrix to get multipliers for agriculture and utilities (assuming that electricity will be similar) which is discussed in the background paper available from the Asian Development Bank

(see footnote 1). The total effect of a \$1 sales increase in agriculture as it multiplies throughout the economy is \$2.37, and for electricity (assumed to come from hydropower), it is \$2.23. Thus, each \$1 of sales adds another \$1.30 or so to sales economy-wide in indirect effects (without re-spending labor payments). These are similar to the Tarbela Dam Study where multipliers based on the 1983 Pakistan Institute of Development Economics Input-Output Matrix were used but are higher than a detailed computable general equilibrium/social accounting matrix analysis of Bhakra in the Indus Basin in India where overall multipliers were approximately 2, but the latter assumes limited resources while input-output models do not.

In Hydropower

WSTF calculations show that it is possible to help the country keep up with demand for electricity by adding infrastructure for hydropower. With 59,200 MW of potential in the mountains of Pakistan, the current electricity crisis could be solved in ways that are environmentally friendly and less costly than importing oil to produce thermal electricity. Thermal production is cheaper to install, but its operating costs are higher. The ESTF reported that costs including capacity, energy, and other supplemental charges ranged from \$0.0049 per Kwh for hydropower from Tarbela Dam (the second cheapest was Ghazi Barotha at \$0.0139 per Kwh) up to \$0.0865 per Kwh in an oil-fired facility. Using locally produced natural gas, the lowest thermal costs were relatively competitive at \$0.0246, but the overall average cost reported in Figure A1.4 was nearer the higher end. The challenges are thus to determine ways to pay for the infrastructure that are fair, to compensate people negatively affected, and to reflect maintenance costs and depreciation in user charges.

At IRSA

In addition to the opportunities for improving technical upgrading, a few other points can be made.

Voluntary re-assignments. There is strong prima facie evidence that individual provinces and Pakistan as a whole would be better off if there were mechanisms whereby some entitlements could be temporarily transferred from one province to another. In some cases this would be because a province is currently unable to use its full entitlement and has legitimate concerns that non-use may eventually lead to a reduction. In other cases, a voluntary transfer (in exchange for payment) would result in water moving from lower-value to higher-value uses.

Financing. Since its inception, IRSA has had no financial independence and is unable to finance its operations and staff. Recently, however, an important agreement has been reached that IRSA will receive earmarked budgets from levies on water delivered to the provinces and on energy generated. If these are collected, this will provide a sustainable financial basis for the authority.

For Building Major Infrastructure

With just 30 days of capacity for storage and the fact that major infrastructure would add electricity to counteract the current crisis, the consensus to move forward on large dam projects has been growing. The ground breaking for Diemer Basha was in October 2011 suggesting a commitment to that project even though financing is not in place. WAPDA also has a set of balanced priorities, many of which have modest resettlement and other environmental issues, so much needed infrastructure can go forward if financing and repayment strategies are found. If the current projects are successful with respect to both financing and stakeholder opinion, WAPDA and other agencies should continue to expand their capacity to handle more complex but needed infrastructure improvements.

Initial reforms of the electricity industry have been made, and the Environmental and Social Cell in WAPDA has been strengthened. The Ghazi Barotha hydropower project has recognized the needs of affected communities and relevant stakeholders and has taken successful actions. The challenges in this scheme, however, were small compared to others, but it certainly shows that WAPDA understands what is needed and will continue to strengthen its capacity to successfully navigate infrastructure development.

To Break the Build-Neglect-Rebuild Cycle

To determine if costs of major infrastructure are affordable, we added together and amortized sample costs of barrages, main and secondary canals, and other infrastructure. The replacement value of assets was amortized over 40 years at a 3.5% interest rate. This is longer than the loan payoffs examined later because the objective is to replace assets, not pay off loans that have a shorter time horizon. We then added annual charges for maintenance and repair and administration to determine the full costs per year of replacing these major assets. The examples are taken from the 2007 Asset Management Plan for Punjab.

Figure A1.6 shows the results and individual costs for the major infrastructure required to distribute water through the irrigation system, from dams through the extensive network of barrages and main and secondary canals. The figure starts from the source of water in a dam (at the top) and shows costs at each step through the irrigation system. These values are on an annual, per hectare basis. The largest cost is to support infrastructure related to the main canals at \$43.68 per hectare followed by dams at \$37.82 per year. Distributory canals cost around \$27 per year per hectare. The overall costs are \$135.47 per year per hectare. For comparison, the gross margin of a wheat producer from a recent analysis of resource conservation technologies was about \$600 per hectare. While the gross margin is not profits and some expenses have to come out, most farmers could afford these costs. Full payment will undoubtedly be a challenge to absorb, especially for smaller farmers, and therefore some participation by the government seems likely to be needed at least over an intermediate time period.

To Reduce Mistrust in Infrastructure Projects

Other countries have had similar experiences with resistance to infrastructure projects as various stakeholders feel that they bear costs but receive few benefits. The key to reducing this perception is to engage them early on, making sure that all arrangements are transparent and that compensation and ongoing benefits are shared in a fair and open manner. A similar situation exists with IRSA where the lack of capacity and modern measurements lead to wide-

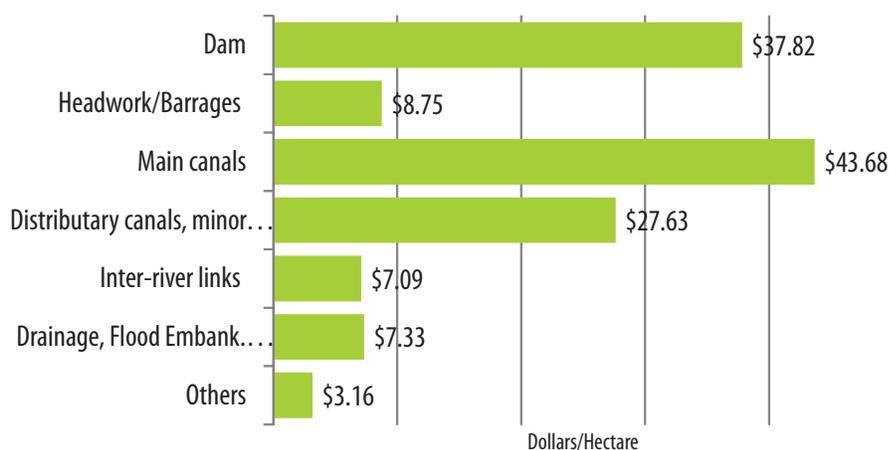


Figure A1.6: Total Irrigation Costs in Dollars per Hectare
Source: Authors' calculations

spread suspicions of its decisions. Donors seeking to fund new infrastructure should encourage improvements in water resource institutions in these regards.

As the WCAP report in footnote 8 notes, “Benefit Sharing is a relatively new concept, nevertheless several countries including Brazil, Canada, Chile, the People’s Republic of China, Columbia, Ecuador, India, Nepal, Norway, and Vietnam and others are ensuring that it becomes an integral part of hydro-power development. This recognition is beyond other means of dealing with stakeholders (compensation).” These examples have just become available in the last few months and should generate discussion among federal and provincial agencies and among donors about how to create a system that meets best practices as quickly as possible so that important infrastructure projects are not further delayed.

The WSTF recommends forming a high-level committee of stakeholders and assessing experiences from other countries including visits to countries with good options. This should lead to a more targeted proposal as a way forward than the current report did (which did include a good review of stakeholders and even proposed legislation). This program should be completed within a year as the capacity to engage stakeholders and adequately share benefits is a critical dimension for moving the infrastructure agenda forward.

The Gains from more flexible dam operating rules

Based on averages from 2008 to 2011, the level in Tarbela Reservoir follows three different patterns in a typical year. It rises steeply from July to the end of August when the reservoir is full then declines slowly to a minimum in mid-December that is maintained through June. This pattern is important because turbines are designed to produce optimum output based on a combination of pressure and discharge with possible substitutions of one for the other. With higher levels in a reservoir, and thus higher pressure, lower discharges can be used to generate electricity. Therefore, changes in operating rules show up as different patterns in the levels in the reservoir as can be seen in Figure A1.3. We created a simple model that uses three linear segments to capture variations in levels using different operating rules (Table A1.4).

Table A1.4: Potential Gains from Changing Operational Rules in Tarbela Reservoir

Scenarios	Observed Output		Optimized Output		Volume	
	Value (\$ billion)	Change from Base (\$ million)	Value (\$ billion)	Change from Base (\$ million)	MAF	Change from Base (MAF)
Actual Base	1.438	--	1.438	--	--	
Base Predictions	1.439	--	1.460	--	47.496	
Raising Early Season Dam Level	1.464	25	1.480	20	47.847	0.351
Raising Early Season Dam Level With Fourth Extension	1.489	50	1.502	42	48.404	0.908
Raising Mid- and Late-Season Levels with Fourth Extension	1.542	103	1.559	99	46.754	(0.742)
Optimized Management (Up 5%)	1.619	180	1.637	177	46.754	(0.742)
Added Off-Season Flows (25%)	1.698	259	1.718	258	49.103	1.607
Diamir Basha Gains from Optimized Management		354		353		

Source: Authors’ calculations

Irrigation-first operating rules. The actual base in the first line shows electricity generated as provided by WAPDA that is used to represent the irrigation-first policy that has been noted at every meeting with WAPDA and IRSA. When valued at \$0.10 per Kwh, the value was \$1.438 billion (corresponding to 14,380 gigawatt hours produced). The three segments were calibrated using an empirical approach based on data provided and on some optimized values. The former showed only a \$1.0 million difference from the base, while the optimized version was about \$21 million, or 1.5%, higher at \$1.460 billion (shown in the line labeled base predictions). There were total outflows of 47.496 MAF through the dam in the base scenario.

Managing Tarbela Reservoir levels to optimize hydropower revenue. The first four simulations basically maintain higher average levels in the reservoir to generate more electricity. In the early season, the level is increased more quickly to fill the reservoir faster to create a higher head and generate more electricity from discharged water. With the completion of the fourth extension of Tarbela, discharges can increase, so that is a second simulation. The releases in the mid and late seasons (corresponding to the second two segments in the model) after the reservoir is full were restricted to keep the average level higher and create benefits from the added pressure in the reservoir. A fourth scenario assumes that there is considerable opportunity to improve power generation through better interaction with the electrical grid, more flexibility in delivering irrigation water, and more attention to maximizing electricity generated. This is simulated by adding 5% to the output for the same discharges (the US Bureau of Reclamation, which manages western US dams, still looks into advanced methods to get more electricity from dam operations, so the potential would seem to be high in Pakistan).

The cumulative effect of these four simulations combined was to increase revenues from hydropower by about \$180 million but decrease releases by 0.746 MAF which affects the benefits of dam operations for irrigation. For example, the loss of 0.746 MAF is worth \$77 million when the value to irrigation is \$0.084 per cubic meter. The overall benefits from electricity generation are less by this figure and the net gain would be \$103 million rather than the \$180 million in the table.

Adding in Diamer Basha options. The two final scenarios relate to Diamer Basha Dam. With storage captured in Basha, flows to Tarbela can increase in the mid and late seasons thereby offering higher average levels compared with the current situation. At the bottom of the table we include possible benefits from improving the management of Diamer Basha Dam assuming that the same 5% improvement applied to Tarbela would be possible at Basha. The last column shows that the cumulative effects are higher due to low season additions from Basha storage, so the overall gain in flows is 1.607 MAF. As the value of water in irrigation is \$0.084 per cubic meter, this is a gain of nearly \$165 million in water value (attributable to Basha).

Action Plan

Priorities for Infrastructure development

Implement the Eight Priority Projects

In recent years the federal government has wisely decided to shelve Kalabagh and put Basha and other projects in Table A1.2 with fewer environmental and social challenges on the front burner. CCI has now approved the construction of the highest priority, namely Basha Dam.

Moreover, there is deep commitment by all relevant political leaders (including the President and Prime Minister and all chief ministers through the CCI) and those with responsibility in key agencies (including WAPDA and IRSA). There has also been major progress, particularly with respect to Basha, to ensure that both affected provinces benefit and to address seriously and up-front the needs of affected people. In short, the Government of Pakistan and agencies like WAPDA have taken many of the right steps.

This report has shown that the eight projects in Table A1.2 will add capacity to address critical issues of flood control, electricity generation from hydropower, and added storage for irrigation. Together, they could provide about 19,000 MW of new installed capacity thereby raising the total electrical capacity by nearly 70%. Munda and Kurram Tangi dams are on western tributaries of the Indus River and, along with timelier flood forecasting techniques, help to reduce flood costs—a priority for KP agencies. Sources of added storage for agriculture lie with the Diamer Basha and Dasu dams. All the environmental aspects of these projects appear to be manageable. In particular, the Ghazi Barotha hydropower project has recognized the needs of affected communities and relevant stakeholders and has taken successful actions.

As Diamer Basha Dam will take the longest to construct (and others will benefit from its successful implementation), important institutional and political steps need to be taken now.

Critical steps in implementing the Diamer Basha Project. In the case of Basha, three issues of fundamental importance must be given priority.

- There must be agreement that the project will be bid following standard international competitive bidding procedures. Given the cost of this project, a very significant degree of international financing is required; success in obtaining funds will require clean approaches to project construction and finance. This should include clear mechanisms on how proposed tariffs on water and electricity are handled to convince international donors that loans can be repaid.
- Early attention must be given to resettled and other affected people to make sure that they are the first beneficiaries. The history of dam construction until very recently has led to a great deal of mistrust regarding the government's concern for affected communities. The poor outcomes of construction at Mangla and Tarbela in the past were likely a factor in the difficulty in getting consensus on large dams, because provinces and affected peoples do not believe that the government will provide adequate benefits and compensation. Recent experience, however, has shown that WAPDA and other agencies understand past deficiencies and are capable of using best practices. During the raising of the Mangla Dam recently, about 50,000 people had to be resettled. The cost of this resettlement, a package for old affectees, and other connected costs was 51% of the total project budget.¹² The resettlement issue for the Tarbela Dam has still not been finalized, but WAPDA intends to settle the case with the fourth extension of Tarbela power stations. The performance of WAPDA in Ghazi Barotha has shown positive experiences in addressing needs of affected communities and other stakeholders. These perspectives prevail in the work on Diamer Basha.
- The revenue formula must insure that affected communities and local areas share in

12. *The Brochure of the Mangla Dam Raising Project*

benefits and are compensated for losses. Currently, revenues from profits go to the general coffers of the provinces in which the powerhouse is located. The eight proposed projects include major benefits from electricity generation that need to be distributed to

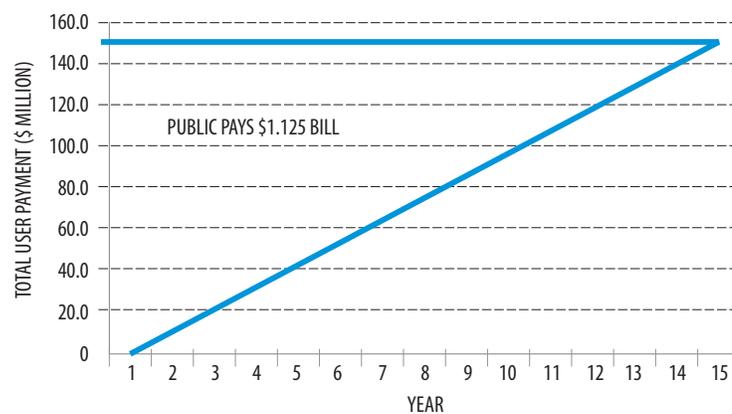


Figure A1.7: Scaling Up User Payments for Irrigation
Source: Authors' Calculations

affected communities and to fund riparian interests. The provinces have not clearly identified income streams to affected communities (although the partnership between Ghazi Barotha management and KP is encouraging), nor is there sufficient transparency regarding benefits going to areas like Gilgit-Baltistan that are not provinces. Attempts have been made to revise calculations of “net profits” and have led to an ongoing dispute between WAPDA and KP on amounts due.

The above concerns were addressed in the Ministry of Water and Power/WCAP work on sharing benefits cited several times earlier (in footnote 8), where a review of policies and practices in 10 different countries was made. Their experiences are well documented and have been applied to Pakistan in the report, so a road map is available.

Other Basha issues to address that are not “deal-breakers.”

Environmental impacts (fish, wildlife cultural heritage) are unlikely to be large (Figure 7 in the main report shows that both the area submerged and people displaced per MW are very low compared with other major projects); good watershed practice is probably the key issue.

Seismicity can reasonably raise alarm, but there are now well-established engineering design practices that ensure stability as the recently-constructed dams showed in recent major earthquakes in Chile, Haiti, and Japan.

International waters should not be an issue since the Indus Waters Treaty gives Pakistan the right to develop the waters of the Indus.

Other Related Steps

Break the build-neglect-rebuild cycle. As shown in Section 3e, costs of major infrastructure are affordable. The annual charges for depreciation, maintenance and repair, and administration were added together to determine the full costs of replacing major assets in the irrigation system. The overall costs are \$135 per year per hectare. For comparison, the gross margin of a wheat producer in a recent study was about \$600 per hectare. WSTF has argued that infrastructure should be improved before tariffs are raised when making a transition to a user-pays system. This transition will require support from the government and donors over the next 10–15 years.

Reduce mistrust in infrastructure projects. Other countries have had similar experiences with resistance to infrastructure projects. The key to reducing this resistance is to engage stakeholders early on, to make sure that all arrangements are transparent, and to ensure that compensation and benefit sharing is done in a fair and open manner. One annex in the WCAP report reviews the experience in 10 countries and points out a number of typical approaches. First, legislation clearly mandates significant engagement with affected communities. Brazil, Canada, the European Union, North America, and Norway have laws that include affected communities as stakeholders and engage them in decisions on benefits early on. The Columbia River Basin Trust in Canada is an excellent, functional example of a mechanism for sharing benefits.

Other notable aspects of the mechanisms are a focus on providing monetary benefits and compensation for losses. In the Columbia River Basin, 3% of revenues are directed to a watershed agency to work with basin communities. India has recently added a provision to route 2% of revenues from hydropower projects to local development funds (in addition to 10% allocated to provinces). In Brazil, 3% of total hydropower revenues are assigned to affected provinces and 3% to affected municipalities with shares calculated on the basis of area and numbers of people affected. This approach has been shown to create higher growth in communities that receive the benefits. Numerous other examples and ideas are found in the WCAP report.

Capture gains by adjusting dam operation rules. By varying reservoir levels in ways other than to accommodate the “irrigation first” model, more electricity can be generated from the same amount of water. With higher levels in a reservoir, and thus higher pressure, lower discharges can be used to generate electricity. Therefore, changes in operating rules show up as different patterns of the levels in the reservoir. Our simple model using three linear segments to capture variations from different operating rules showed an increase of up to 20% in revenues could be possible which could be close to an added value of \$300 million per year. Much of this gain is only possible in conjunction with opportunities that arise with the construction of Diamer Basha Dam. The management of WAPDA at Tarbela Dam is currently undertaking a significant review of operations rules for just this reason. This should be encouraged at the highest levels of government, and the review should be made public so that a meaningful debate about the irrigation-first policy can be based on scientific evidence and possible benefits foregone.

Strengthen IRSA

A comprehensive institutional review of IRSAs capacity, potential, and needs was done as part of the WCAP program. A number of financial and technological and capacity building options were suggested. These should be inspected carefully to determine a reasonable action plan for making IRSA a better manager of the complex water system.

Strengthen Selected WAPDA Capacities

With long experience and significant capacity in engineering and project management, WAPDA has demonstrated many abilities. They have successfully put out tenders and managed oversight of a great deal of large infrastructure; this is understood by donors. They have managed two of the world’s larger dams for a half century. WAPDA has also shown that it can handle issues of seismicity and respecting cultural heritage; however, Pakistan has an ambitious infrastructure development agenda. To attract and use international financing, WAPDA’s capacity to effectively implement safeguards must be further developed. This essentially means to continue improving the capacity of the Environmental and Social Cell to manage safeguards and environmental and resettlement concerns.

The increased volume of water in the main Indus, the Jhelum, and other rivers with substantial glacier areas must be taken into account when planning for water releases from dams and for new infrastructure. Old data on reservoir volume and capacity curves for turbines will need to be recalculated. The need for glacier mass balance measurement ability is increasing; the glacier hydrology program must be given full support both within WAPDA and from donors. Cooperation with International Centre for Integrated Mountain Development and the Meteorological Department is positive, but WAPDA's future planning and operations needs should be given first priority in the measurement program.

In the future, enshrining both profit-sharing and resettlement practices into codes of practice that build on good Pakistani experience and the best of global good practice is necessary.

Costs, Recommended Actions for Stakeholders, and Next Steps

Costs of Developing Major Infrastructure

Table A1.5 gives the yearly costs for the eight major infrastructure projects proposed by WAPDA. The costs were based on an annual WAPDA financial plan with somewhat older total values that was updated to make the yearly pattern of expenditures consistent with the latest costs. Three projects—Diamer Basha, Bunji and Dasu—account for over 80% of expenditures. They also have long construction periods, as Diamer Basha will require 12 years and Bunji and Dasu are expected to require 8 years each; years 5, 6, and 7 will require somewhat over \$4.0 billion annually in financing.

Because four of these projects are ROR hydropower schemes, electricity generation accounts for earlier revenues and higher values. The choice to emphasize hydropower may partly be related to the costs of resettlement and environmental safeguards, the possibility of attracting the private sector, and the relative ease of capturing revenues due to that industry's structure; however, it delays providing storage needed for agriculture.

Table A1.5: Costs over Time for Major Infrastructure Projects (US\$ million)

Year	Diamir Basha	Golen Gol	Kurram Tangi	Munda	Kohala	Tarbela 4	Dasu	Bunji	Year Total
1	4	22	133	0	0	275	0	0	435
2	843	46	276	140	240	275	0	684	2505
3	794	35	179	140	240	275	0	684	2347
4	1082	27	111	280	480	0	390	1026	3397
5	1288	0	0	280	480	0	781	1368	4196
6	1336	0	0	280	480	0	781	1368	4245
7	1493	0	0	0	480	0	1171	684	4108
8	1509	0	0	0	0	0	1561	684	3754
9	1109	0	0	0	0	0	1561	342	3013
10	630	0	0	0	0	0	781	0	1410
11	542	0	0	0	0	0	781	0	1323
12	547	0	0	0	0	0	0	0	547
13	0	0	0	0	0	0	0	0	0
Proj. Total	11178	130	700	1401	2400	826	7807	6838	31280

Source: WAPDA data and author's calculations

Based on the earlier discussion, \$0.0694 per Kwh is used to value benefits of each Kwh of electricity, while \$0.084 was the value used for water. (Sensitivity analysis is reported below to determine the importance of these assumptions). The net present value of costs and benefits across 43 years was shown in the related background paper using 13 years to get to full capacity and then 30 years of income. This stream of costs and benefits yields a net present value (NPV) of \$65 billion (accounting for the costs of \$31.2 billion) and an internal rate of return (IRR) of 13%. Even if the values per unit of output are half what we use, the NPV is \$21 billion with costs absorbed, and the IRR is 8% suggesting that significant value is derived from these projects (which will last much longer than the time periods used in this financial analysis.)

Financing Dams and Other Large Infrastructure Development

With such NPVs, the income derived from these projects creates significant benefits and the means to pay back loans exist. Important dimensions needing examination are the affordability of the infrastructure, cost allocation (who will pay), and the feasibility of collecting revenues from different sources.

Regardless of who pays, our assessment is that the benefits are significant and the costs are affordable. For instance, the stream of costs and direct benefits of the eight major infrastructure projects together yields an NPV of \$65 billion and an IRR of 13%. Excluding the “public good” benefits of flood control, WAPDA uses a ratio of 60% of benefits from hydropower and 40% from irrigation to allocate costs. If costs of the four multifunctional projects are repaid based on benefits received, an additional \$720 million from electricity users and \$480 million from irrigators is required. Based on output, the loan portion for electricity could be covered with a surcharge of about \$0.017 per Kwh on hydropower. These costs appear to be affordable and are well within the range of current practice and proposed charges.

As noted earlier, however, WAPDA makes proposals to NEPRA for tariffs that cover operation and maintenance costs, depreciation, return on equity, and added amounts to finance later projects and therefore calculates that the priority hydropower projects would require a tariff of about PRs4. Our number does not include these additional financial obligations. For perspective, if the tariff charged on new hydropower were spread across all future electricity production (around 168 Twh), it would raise costs by about PR1, a small portion of the recently announced increase of up to PRs18.60 for peak periods.

Determining benefit proportions is driven by two factors: irrigation releases from storage versus hydropower production and the values attached to each output. After the fact, it is possible to assess values accurately which was done for the World Commission on Dams study on Tarbela Dam that compared predicted and actual benefits. Economic benefits exceeded predictions by about 67%, and financial benefits were about 7% above predictions. The difference between these results is that economic analysis uses avoided costs for thermal power as hydro benefits and uses different exchange rate effects.

The predicted proportion of benefits was 65% from irrigation and 35% from hydroelectric power in economic terms and 60/40 in financial terms. Ex post facto, the commission’s study found that the proportions had moved toward power generation as the benefits were 61% from irrigation and 39% from hydroelectric power in economic terms and 51/49 in financial terms. The march toward a higher proportion of benefits from power generation has continued: WAPDA will use a 40/60 split between irrigation and power in its request to NEPRA for tariffs

to cover costs of Basha. Moreover, our calculations for Basha benefits are 65% power and 35% irrigation and for the four multifunctional infrastructure projects in Table A1.2 (Diamer Basha, Kurram Tangi, Dasu, and Munda) the ratio is 74% electricity and 26% irrigation. If world prices for fuel continue to rise and the rupee declines, the relative benefits from cheap, locally produced hydropower will continue to grow. The capture of carbon credits would further enhance the benefits of the hydropower projects.

Thus, with regard to electricity from hydropower, the government has a well-developed, transparent process for determining tariffs to cover that portion of the costs of priority infrastructure (60%). These charges are affordable, can be collected easily, and are likely to grow in relative importance given the dynamics of the rupee and world energy markets.

Capturing the benefits from irrigation water is more complex. In principle, the charges to support 40% of a loan to pay for multifunctional infrastructure are affordable as they could be covered with a surcharge of about \$25 per irrigated acre (compared with annual costs of pumping groundwater of between \$20 and \$80 per acre and gross margins of \$250 per acre for wheat). This value is of course significantly above that charged to agricultural users at this point, and that small amount is not collected consistently. There are three options for covering the water bill:

- Option 1—the ideal—would be to pass it on to water users through a regulatory process similar to that for electricity, but there is no such process and even the current abiana system does not work (and is under the jurisdiction of the provinces).
- Option 2 is to pass the bills on to the provinces proportional to the additional water that they receive. There is some precedent for this as CCI has approved IRSA charging small amounts for water delivered to the provinces. It is unlikely, however, that the provinces would permit the CCI to charge greater sums, so there is little likelihood that this mechanism would function.
- Option 3 is for the federal government to simply assume the water bill as part of overall federal debt as it does for Asian Development Bank and World Bank-financed irrigation and barrage projects; this is the common practice in most major infrastructure projects worldwide. There are many shortcomings to this approach, but it is the only one likely to function. The WSTF estimates that the new outputs will lead to direct and indirect effects of about \$10.2 billion, so 5% of that collected in general taxes would fully cover the bill.

Phase in Benefits before Increasing Costs to the Public

A recurrent theme in the main report is that while the endemic problems of cost recovery in the electricity and water sectors are hugely important, they cannot be addressed by simply raising tariffs. The only politically feasible way of breaking the vicious cycle of “poor service/unwillingness to pay/worse service” into a virtuous cycle of “good service/high willingness to pay/better, financially sustainable service” is to (i) improve service, (ii) find transition mechanisms for assuring adequate revenues for suppliers through a combination of user charges and contributions from government and donors, (iii) inform users that tariffs will be gradually increased to make improved services financially sustainable, and (iv) provide a direct routing of tariff funds to prescribed uses, not to the general coffers of the government.

Taking taxes proposed as an immediate tariff on all electricity and irrigation water, we can estimate the public sector investment needed to phase in the user-pays approach. To successfully and sustainably cover costs, the government must demonstrate benefits and will need time to

make the case that payments are going to good use. A simple approach would be to linearly shift costs from the public sector over some time period to irrigation users as shown in Figure A1.7. If costs of \$150 million (the \$135 annual cost for infrastructure per hectare on 11 million hectares) were shifted to irrigators over 15 years, total costs to the government and would be \$1.125 billion. If that timeline were shortened to 10 years, there would be a total cost of \$750 million. These appear to be costs worth bearing for such an important institutional shift. A similar calculation could be made for hydropower where the initial tariff would be paid by the government, but this tariff is more affordable than the one for water, and consumers are paying ever higher prices, so there is less imperative to implement the process in electricity.

Summary of Large Infrastructure Projects

There is deep and broad-based political commitment by the Government of Pakistan and key agencies to addressing the issues described in this annex. The WSTF recommendations are the following:

For the Government of Pakistan:

Re-double ongoing efforts to transform IRSA into an agency that can implement the Water Accord with less political dissension. This means strengthening the governance of IRSA, securing its financial basis, and investing heavily in modern approaches to estimating water availability and to measuring and reporting on water deliveries and losses. Twinning arrangements with river basin agencies like the Murray Darling and Mississippi can help develop the human and knowledge resources of IRSA.

Formulate a constitutional amendment so that the mechanisms for sharing the profits from hydropower projects conform to global good practice thereby causing affected provinces and municipalities to welcome such projects.

Transform the good practices developed for dealing with resettled people at Ghazi Barotha into standard operating practices for all future projects. This will include substantially strengthening the capacity of the social and environmental arm of WAPDA. The objective should be to make local people the first beneficiaries of any such projects.

Using the forthcoming analysis of the Tarbela Dam operating rules, determine the costs and benefits of making changes and communicating transparently with stakeholders.

For the FODP and development partners:

Upon request, assist Pakistan to develop the knowledge base, human resource capacity, and technology for managing the Water Accord. Particular emphasis should be given to twinning arrangements with successful entities like the Mississippi River Commission and the Murray Darling Basin Authority.

Insist that support for large infrastructure investments be coupled with support for improving the capacity for implementing the Water Accord and making local people the first beneficiaries of such projects.

Progress on this agenda is an existential issue for Pakistan; principled and pragmatic support from the FODP is vital. FODP must provide direct financial support and seek support on the boards of the World Bank and the Asian Development Bank for the highest-priority, major infrastructure projects of the Government of Pakistan in a pragmatic manner that prioritizes those concerns that are of major import (including competitive bidding, equitable and transparent sharing of royalties, and making affected people the first beneficiaries) and deals pragmatically with the host of other issues (environmental impact, cultural heritage, international waters, disputed territories) that are relevant in any such project but are not potential deal breakers.

Situation Analysis¹

Water Availability and Demand

The Indus Basin Irrigation System (IBIS) has received an average annual river flow of 136 million acre feet (MAF) from the western rivers—the Indus, Jhelum and Chenab—since the Tarbela Dam was constructed in 1968 as measured at the rim stations. Seasonal, annual, and daily river flows in the IBIS are highly variable. Average summer season (kharif) flows are 114 MAF (about 84%) and average winter season (rabi) river flows are 22 MAF (16%). The rabi season flows are almost 20% of those in the kharif season because of limited glacier and snow melt and low rainfall. The eastern rivers (Ravi, Sutluj and Beas) contribute 7.0 MAF of water in an average year. Thus, the total mean annual flow from both western and eastern rivers is about 143 MAF.²

Estimated annual recharge to groundwater in the IBIS is about 55 MAF out of which 36 MAF occur in the freshwater zone.³ The fresh to marginal quality groundwater reservoir in the IBIS is around 600 MAF (surface area of 16.7 million hectares and average depth of 30 meters with a storage coefficient of 15%) which is equivalent to over 4 times the mean annual river flows. The current abstractions of groundwater are high at close to 49 MAF and are increasingly in danger of turning saline.⁴ The water quality concerns combined with the cost of pumping has raised the question whether increased use of groundwater in the future is sustainable.

In the IBIS, crop water requirements (CWR) have radically increased as a result of increased cropping intensity and the cultivation of high water consuming crops such as rice and sugar-cane. Currently, a cropping intensity of over 150% is quite common when the designed intensity was 65% as shown by data relating gross canal inflow to CWR commands.⁵ The main exceptions are canal commands such as Fuleli, Pinjari, Kalir, and Pat Feeder/Desert where there is still scope to rationalize and promote more groundwater use. Considering the gross inflow

1. A background paper on agricultural productivity is available from the Asian Development Bank.

2. Ahmad, S. 2008a. Keynote Address on “Water Shortage and Future Agriculture in Pakistan – Challenges and Opportunities,” Proceedings of the National Conference on “Water Shortage and Future Agriculture – Challenges and Opportunities”, Agriculture Foundation of Pakistan. August 26-27, 2008, Islamabad, Pakistan.

3. Zuberi, F.A. and A.B.Sufi. 1992. State of art of groundwater exploration, exploitation, management and legislation. IWASRI, WAPDA, Lahore, 26 p.

4. GOP 2010a. Agriculture Statistics of Pakistan. Economic Wing of the Ministry of Food, Agriculture and Livestock, Government of Pakistan.

5. Habib, Z. 2010. Policy and Strategic lessons from the evolution of water management in the Indus Basin. The Planning Commission, Government of Pakistan, Islamabad.

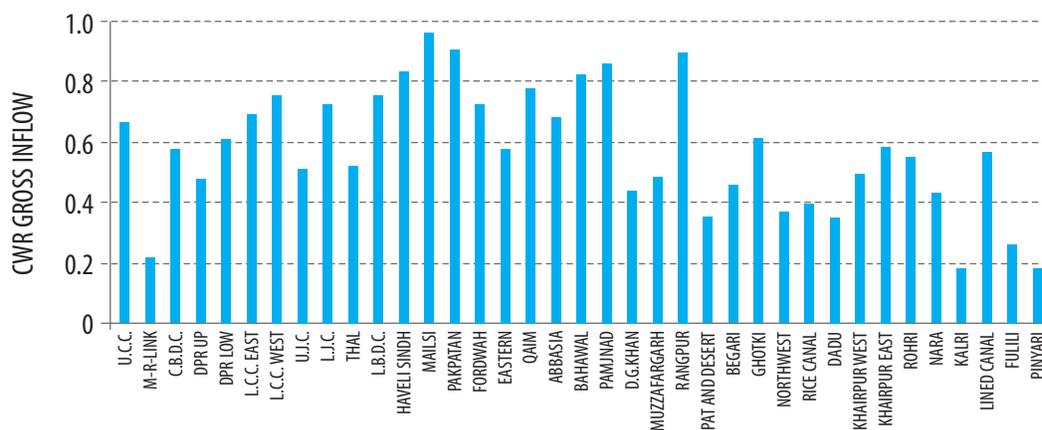


Figure A2.1: Crop Water Requirements as a Fraction of Gross Inflow
 Source: World Bank 2006. *Water Balance – Background Paper* by Ahmad, S. In: *Water Country Assistance Strategy, Pakistan's Water Economy Running Dry*, World Bank Resident Mission, Islamabad

(water diversion at the main canal intake plus rainfall), the perennial main canals in the IBIS are short of water in comparison to the CWR (Figure A2.1). The actual water scarcity is much more since only 40% of the canal diversions are available for crop use. The major cropping patterns in the IBIS are maize-wheat, rice-wheat, cotton-wheat, and sugarcane-wheat with a mix of other minor crops, fruits, and vegetables.

There are two lines of action to follow to move to higher productivity in the intensively used canal commands in Punjab: (i) more efficient use of canal water by improving the performance of the canal irrigation system; and (ii) optimizing recharge within the canal commands.⁶ In Sindh there is scope for a rationalization of canal supplies as waterlogging is still widespread.

Indus Basin Irrigation System

Irrigated agriculture is an important sector of the country's economy since it provides over 90% of agricultural output. With a command area of over 45 million acres, the IBIS is the largest contiguous surface irrigation system in the world. Irrigated agriculture, however, is by far the largest water user consuming over 93% of available water. Water allowances of perennial canal commands vary from 2.8 to 8.5 cubic feet per second (cfs)/1000 acres. This wide variability is difficult to explain. There are differences in CWR, but these differences are not significant except for rice, sugarcane, and banana. The higher water allowances in some of the

6. Ahmad, S. 2008b. *Land and water resources of Pakistan – A critical appraisal*. Paper presented in 23rd Annual General Meeting & Conference of Pakistan Society of Development Economists (PSDE). Broad theme of 'Natural Resource Management: Issues and Challenges'. Islamabad, Pakistan.

non-perennial canal commands are one of the factors responsible for water-logging and salinity. Water allowances for non-perennial canal commands vary from 5.5 to 17 cfs/1000 acres, a much higher variability than perennial canals.⁷

The performance of the canal irrigation system is low both in terms of water adequacy and reliability. First, overall reported irrigation efficiency is about 40% which means 60% of water available at the head of the main canal is lost either in conveyance or during its use at the farm. When this “lost water” percolate to a freshwater aquifer it does not, of course, represent a real loss of water, but does imply an additional energy cost to again life the water. When seepage is to a saline aquifer this represents a real loss of usable water. Second, the system design takes a known amount of river diversion and distributes it among all users within its command area according to a fixed proportion. There is no intermediate storage between the main canal intake and farm production (nacca). As such, water diverted in the main canal must run downhill through the maze of branch and distributary canals eventually arriving at the farm gate in quantities unknown to the farmer. Water users have very little control over how much water they will receive during a given turn. In response to this unreliability in the canal system, farmers in the IBIS have developed a large number of tube wells to utilize groundwater. These tube wells currently pump around 49 MAF of groundwater compared to average canal water deliveries of about 103 MAF. From the early 1960s, groundwater use has made the green revolution possible in Pakistan and has made it possible to have water on demand.

The unregulated use of groundwater, however, is facing critical problems now as the cost of pumping has increased with high electric tariffs and the removal of subsidies on diesel fuel. It is evident that the era of uncontrolled groundwater expansion is over as there is hardly a 10% potential for further development, and it is largely in the marginal to brackish zone. Thus any further abstraction of groundwater in the intensively perennial canal commands, especially in Punjab, is not going to be sustainable. It is therefore important to support the judicious use of groundwater and to improve the use of canal water to reduce the need for groundwater, while tapping the scope for more recharge within the canal commands from floods, high flows, and rainfall. This requires delivering canal water in a reliable, equitable, and transparent manner. In some of the canal commands with very high irrigation duties, efforts to adjust canal water allowances to CWR and overall irrigation efficiency to control waterlogging are needed.

Areas Outside IBIS Canal Commands

These areas fall into the following six categories:

- The dry mountains of Gilgit-Baltistan have small-scale, surface irrigation systems that use snow and glacier melt and are located above the rim station of Tarbela. The rim station is the measurement station for river inflows into the IBIS.
- The mountainous region of the Federally Administered Tribal Areas (FATA) comprises small-scale groundwater, floodwater, and perennial irrigation systems for irrigated agriculture. Rainfed agriculture prevails in areas with significant rainfall.
- The mountainous and sub-mountainous areas of Azad Kashmir (AJK) have rainfed and irrigated farming systems located above the rim station of Mangla.
- The barani areas of Pothwar Plateau have rainfall in the range of 350 to 1000 millimeters (mm) per annum. Small-scale irrigation systems are based on stored water in medium-sized and small dams and command a total area of over 30,000 hectares. There are over

7. *The World Bank. 2006. Water Balance - Background Paper by Ahmad, S. In: Water Country Assistance Strategy, Pakistan's Water Economy Running Dry, World Bank Resident Mission, Islamabad.*

1200 mini dams with much smaller storage owned by individual farmers contributing a total command area of 2000 hectares.

- Spate irrigation systems prevail mainly in Balochistan, Khyber Pakhtunkhwa (KP), and Punjab, and floodwater is diverted into a well-defined canal network for delivery to large banded fields with a potential to supply over 2 million hectares.
- Rainfed farming along the adjacent slopes and rainfall-runoff farming prevail in Balochistan and in the Sindh Kohistan area. In Balochistan these areas are called khushkaba.

Current State of Command Area of Small and Medium-Sized Dams

Many areas outside the IBIS canal commands have large variations in rainfall, runoff, and floodwater; the poorest-of-the-poor live in these areas.⁸ The current potential area under barani farming is 3 million hectares (footnote 4). With the support of the Asian Development Bank (ADB) since the mid-1960s, the governments of Punjab and KP have invested in 100 small dams and a dozen medium-sized dams to provide supplemental irrigation for otherwise rainfed farming. The water allowance from the live storage capacity of small dams is 1–10 acre feet/acre.⁹

About 80% of small dams are able to irrigate less than 50% of the designed command area primarily because of inadequate command area development (footnote 8). In addition to technical factors, scattered populations, lack of experience in irrigated farming, and limited infrastructure are the reasons for the slow transition to irrigated agriculture. Farmers are not in a position to cultivate land as services for land forming—a pre-requisite for surface irrigation—are not available. Low-value crops are grown, and average cropping intensity is 100% whereas farmers having access to groundwater can obtain a cropping intensity of 200%. There is a potential to harvest shallow groundwater generated from seepage from the reservoir and canal network.¹⁰

The Punjab Barani Development Project has invested in mini dams since the mid-1990s, and there are now 1200 of them with very small storage, all individually owned. Their contribution to irrigation is a fraction of that of the small and medium-sized dams. As they are individually owned, surface irrigation benefits largely stay with the individual farmer, but in certain areas the community benefits from stock water and shallow groundwater around the periphery of the pond. Enlightened farmers manage their systems efficiently using freshwater fisheries and poultry farming.¹¹

Spate Irrigation and Floodwater Management

There is a large potential for developing spate irrigation by harnessing floodwater. It is suitable for farming oilseeds, pulses, fodders, guar, and beans. Truffles are also found in these areas and represent a special niche. Spate irrigation occurs west of the Indus and is called nai in Sindh, sailaba in Balochistan and rod kahi in KP and Punjab. Traditionally, floodwater is diverted by

8. ADB. 2008. *Country Environment Analysis. Islamic Republic of Pakistan. Pakistan Resident mission, Asian development Bank, Islamabad.*

9. PARC. 2010. *Basic Facts and Revised Strategy for the Design and Construction of New Small Dams in Pakistan. Pakistan Agricultural Research Council, Islamabad.*

10. I. Ali, S. Majeed, S. Zaman, S. Ahmad, B. Ahmad, and S. Kokab. 2010. *Situational Analysis of Ghabir Dam – Current State of the Command Area. NRD Research Briefings Vol. (2), No. (15), NRD, PARC, Islamabad, Pakistan.*

11. Majeed, S. I. Ali, S. Zaman and S. Ahmad. 2010. *Productivity of Mini Dams in Pothwar Plateau: A Diagnostic Analysis. NRD Research Briefings Vol. (2), No. (13), NRD, PARC, Islamabad, Pakistan.*

communities with the help of earthen diversion bunds using local materials that wash out in high floods causing heavy damage in the command area. Once diverted, floodwater is guided and spread over sometimes very long distances usually taking care to ensure that the flood does not erode the soil. Spate irrigation is characterized by the following:

- floodwater from hill-torrents diverted through natural, earthen bunds or through weirs;
- headworks for diverting floodwater into a canal network or tanks for storage; and
- systems combining both non-perennial and perennial flows.

The National Engineering Services Pakistan, Ltd. (NESPAK) estimates the potential area for spate irrigation at 6.9 million hectares based on estimated floodwaters of 18.5 MAF in an average year. Though local land availability needs to be factored in as well, it is clear that the unused potential for spate irrigation is high. The largest potential is in Balochistan, but there is considerable scope in other provinces including areas of D. I. Khan and D. G. Khan.¹² The Pakistan Agricultural Council (PARC) has implemented spate irrigation projects in D. I. Khan, D. G. Khan, Barkhan, and Thana Bula Khan covering all provinces, and according to their estimates, the potential is 2 million hectares considering water allowances of 4 acre-feet per acre, the bare minimum for spate irrigation schemes.

Institutional Reforms and Experiences in the Last Decade

Legislative Acts of the Provincial Irrigation and Drainage Authorities (PIDAs) were approved by the Provincial Assemblies in 1997, where institutional reforms were proposed for provincial irrigation departments (PIDs) and pilot area water boards (AWBs) were suggested at the canal level. Four pilot AWBs in Punjab and 3 AWBs in Sindh are functional. These Pilots are being managed by PIDA in Punjab and SIDA in Sindh. The other canals are still being managed by the IPDs. The PIDA Acts specified that the pilots were to operate for seven years and then reviewed and definitive decisions made on the institutions for managing irrigation. This has not happened. After the completion of the NDP, the Pilot AWBs were not abandoned and are being kept under PIDAs. KP and Balochistan have not continued the pilots initiated by the provincial Irrigation and drainage departments.

There is a need to revisit the concept of PIDAs so that their activities are restructured to the formation and continuity of FOs in all areas. In Punjab it has already been done, as farmers' organizations have been constituted on each and every distributary but functional only in the pilots.

Diagnosis

Challenges

The water users and the system managers face many challenges in the IBIS that result in the current low level of agricultural productivity. Some of the major challenges are the following:

IBIS Canal Commands

Based on the original design objectives, the IBIS has certainly served its purpose well; however, many changes have occurred in the past 100 years of operations including the following:

- an increase in irrigated command areas from about 11 million hectares in 1950 to over 16 million in 2011;
- an increase in cropping intensities from a designed intensity of 65% to currently over 150% in a number of commands of Punjab and Sindh;

12. NESPAK. 1998. *Master Plan for the Development of Hill-Torrents in Pakistan*. National Engineering Services of Pakistan, Lahore.

- a diversification in cropping patterns with farmers opting for more water-intensive crops such as rice and sugarcane (largely because of groundwater use in Punjab and additional water provided after completing the large storage dams of Mangla and Tarbela) instead of the design objective of subsistence crops such as wheat, oilseed, and coarse grains;
- a chronic lack of routine maintenance and poor asset management;
- the advent of groundwater to supplement canal water supplies that is currently very expensive and totally unregulated;
- increased seasonal water shortages especially in the downstream ends of distributary canals;
- deteriorating soil health because of continuous, intense use and fertilizer application;
- problems of waterlogging and salinity; and
- shrinking groundwater resources in Punjab and Balochistan that risk of turning saline, especially in Punjab.

Irrigated agriculture is facing a number of challenges. Whereas the demand for canal water has increased sharply, the water supply available at the rim stations has essentially remained the same as no new reservoir to conserve excessive discharge into the sea has been built on the Indus since Tarbela Dam. This, combined with increased cropping intensity and the cultivation of high water-consuming crops, has led to serious water stress that the farmers have compensated for by pumping groundwater. This option is expensive, combined with the fact that groundwater is in danger of turning saline due to ingress from marginal zones. It should be noted that large dams, while extremely necessary, will not improve the efficiency and reliability of the performance of the irrigation system. Several additional structural and organizational improvements will be needed to accomplish that.

Asset management has been a chronic problem in the irrigation system as the IPDs have routinely deferred maintenance. An often cited problem is the shortage of funds that is exacerbated by the fact that water users are apparently unwilling to pay the very low abiana (water charges).

Drainage of irrigated lands in many ways is a bigger problem, especially the lower riparian of Sindh. Given the flat topography and heavy textured soils, rationalization of surface supplies and drainage is a must for most soils in Sindh, but very few lands were installed with relief and collector drains. Although completed, the left bank outfall drain, which was designed to remove saline effluent but not to cope with storm water, has not functioned effectively at its discharge point and often overflows and backflows cause flooding. The right bank outfall drain is not yet complete. The challenge is that there is no culture of management of the drainage network, so deferred maintenance has resulted in periodically having to rebuild the network.

Groundwater

Since 1976, the contribution of groundwater to irrigated agriculture has doubled from 25.6 to 48.6 MAF (footnote 4). There are now 1 million tube wells powered either by electricity (15%) or by diesel (85%). The increase in electric tube wells has slowed due to the rise in the electricity tariff and to power outages. In Balochistan, the government subsidized electric power for tube wells which led to over pumping and reducing the groundwater table and even to the collapse of some aquifer systems. With the rise in tariffs and diesel prices, farmers in the overstretched areas would prefer not to further expand groundwater pumping provided better quality canal water is available.

The Potential for Increasing Agricultural Productivity

There is great potential for increasing agricultural productivity per unit of land and water through improved water management as farmers who balance the use of fertilizers and use water efficiently have done. The data in Table A2.1 compare national average yields for four major crops with the yields of these progressive farmers. Cotton and sugarcane crops in particular could be more than doubled.

Table A2.1: Potential for Increasing Yield of Major Crops

Crop		Progressive Famers (tons/hectare)	National Average (tons/ hectare)	Potential for Increasing Yield (%)
Wheat		4.6	2.9	59
Cotton		2.6	0.7	271
Rice	Basmati	--	1.7	--
	IRRI	3.8	3.3	15
Sugarcane	Sindh	200	58	245
	Punjab	130	50	160

Source: Final Report of the 2009 Government of Pakistan Task Force on Food Security

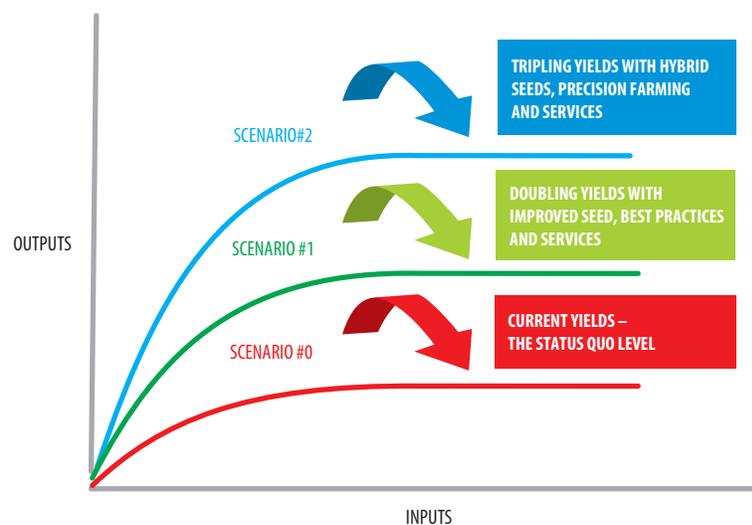
Opportunities

Closing the Productivity Gap

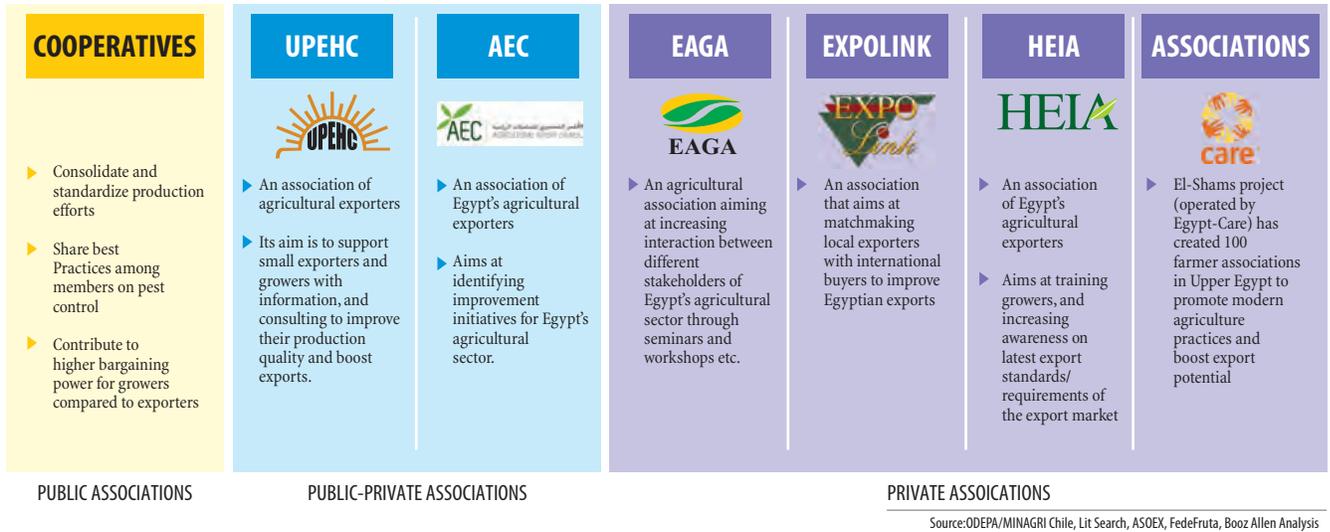
The current average yields of major crops are only half the potential of high-yielding crop varieties coupled with best practices (i.e. balanced use of fertilizers, efficient use of water). Production could be tripled by improving services in the private sector, effectively enforcing regulatory measures for quality control of inputs, establishing highly efficient and reliable irrigation systems, using hybrid seeds, and providing market support. The emphasis should be on hybrid seeds, precision planting, smart fertilizers/re-mineralization, and best management practices.

The conceptual framework for tripling agricultural production in Punjab is based on the practical approach in Figure A2.2. Scenario #0 represents the current level of productivity in the province. For Scenario #1, extension and services support are important whereas for the Scenario #2 technical advances and management support is more crucial. Also, related policies, institutions, and technologies have to be adjusted for both.

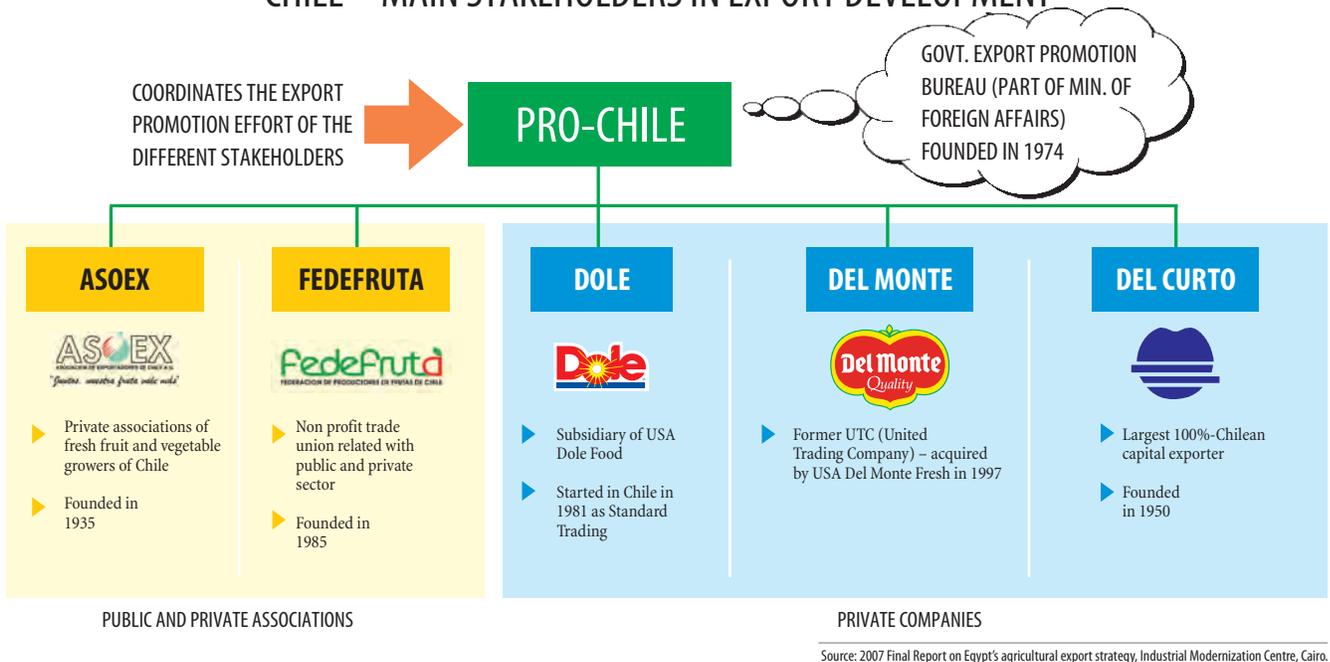
Figure A2.2: Conceptual Framework for Tripling Agricultural Production in Punjab
Source: Authors' compilation



EGYPT – MAIN STAKEHOLDERS IN EXPORT DEVELOPMENT



CHILE – MAIN STAKEHOLDERS IN EXPORT DEVELOPMENT



High Performance Agriculture

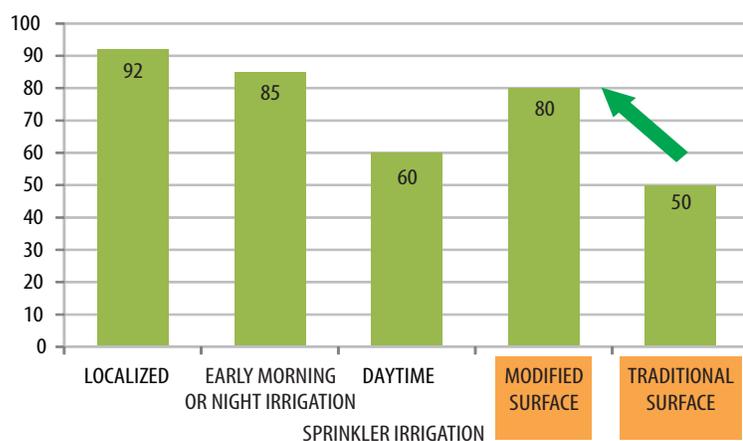
Egypt is an excellent example of high performance agriculture because farmers there follow best practices for water and non-water inputs. Their yields are 6.5 tons/hectare of wheat in the Nile Delta and 5 tons/hectare in newly reclaimed lands compared with 2.9 tons/hectare in Pakistan. The corresponding figures for sugarcane are 120 tons/hectare in new lands compared with 55 tons/hectare in Pakistan. The yield of fruits and vegetables in greenhouses using drip/micro-sprinklers or of in fields using center-pivot sprinkler irrigation is also much higher than in Pakistan.

Egypt has extended the concepts of new vision agriculture into the desert with high efficiency irrigation systems and high-tech agriculture largely for export through public-private partnerships and private industry farming. Their three-pronged agricultural export strategy was modified in 2007 using the model of Chile that emphasizes public-private partnerships and private associations (Figure A2.3). Multinational corporations brought state-of-the-art tech-

Figure A2.3: Agricultural Export Development in Chile and Egypt

Figure A2.4: Efficiency of Different Irrigation Methods in Egypt in 2011

Source: Egypt Ministry of Agriculture and Land Reclamation



nology for water productivity and higher profitability by offering premium prices for exports; this demand for exports was the key to introducing innovative, modern farming in Egypt.

Sprinkler irrigation in 2011 was estimated to be 85% efficient in Egypt, and local irrigation using drip/micro-sprinklers was 92% efficient while traditional surface irrigation was 50% efficient but could be increased to 80% under modified surface irrigation using the concept of incomplete irrigation (Figure A2.4). This is a clear indication that using fertigation systems and best management practices makes water productivity significantly higher than traditional surface irrigation systems.

There are enclaves of high performance agriculture in Pakistan. One excellent example is the Okara Potato and Vegetables Growers Association. This organization imports potato seed from Switzerland, multiplies it in Gilgit-Baltistan and distributes it to hundreds of members in the plains who have cold chains for storing potatoes, fruits, and vegetables. They produce the most potatoes in the country.

Another such enclave is the Soan Valley in Punjab where farmers raise three crops of cauliflower after one crop of wheat. Their first and second crops of cauliflower are off-season and early season and fetch premium prices. The net income from the first crop is Pakistan rupees (PRs) 100,000/acre, for the second crop is PRs 50,000/acre, and for the third crop PRs 25,000/acre. The growers' association imports cauliflower seed from Japan and has established effective links with local markets. These farmers have, however, overused groundwater and are now actively involved in groundwater recharge through watershed management with the support of Soan Valley Development Programme, a local nongovernment organization (NGO).

New Irrigation Infrastructure in Areas outside IBIS

One highly successful effort has been the development of small/medium-sized dams that can store inflows and then release the stored water for supplemental crop irrigation. This option can be very beneficial especially when coupled with the use of high-efficiency irrigation systems (furrow, sprinkler, and drip) and other related inputs. The objective must be to diversify income through the integration of the watershed, the reservoir, and the command area. The watershed area can be used for producing timber, fuel wood, and grasses; the reservoir can provide freshwater for aquaculture; and the command area can be used for high-value agriculture. This model has the potential to increase productivity and production dramatically and will provide ample job opportunities for unemployed youth. An added advantage is that the infrastructure can be developed and managed through the involvement of private sector operators.

Priority Actions

The central effort of the Water Sector Task Force (WSTF) was to consult with farmers, bureaucrats, the private sector, and political leaders in workshops, meetings, and field visits to articulate the initial steps of an action plan to start moving Pakistani agriculture “from a low-equilibrium to a high equilibrium system.” In this context, the agricultural productivity team assessed priorities not only from the perspective of the experts but also from that of the political leadership at the highest level asking for the advice of the WSTF. The outstanding example was in Punjab where the chief minister has a vision of “Punjab as a regional agricultural power house” and has engaged other political leaders, the private sector, and the bureaucracy to identify efforts to translate that vision into actions. The chief minister saw the WSTF as an opportunity to push this agenda forward and with the WSTF organized a workshop on 20 and 21 July 2011 in Lahore attended by stakeholders largely from government and private sector institutions and companies (national and multinational). In addition, group meetings with stakeholders were held in all provinces during which members of the team discussed water management and agricultural productivity.

The interactive workshop started with presentations from a variety of progressive farmers and private agricultural companies. The focus was on what they had achieved, what constraints they faced, what was stopping average farmers from increasing productivity, and what the government needed to do. There were also presentations from farmers’ organizations on constraints and challenges. Finally, the Government of Punjab described how it perceived the challenge and how it intended to turn the chief minister’s vision into reality. Although the discussion was specifically about Punjab, the three recommended actions that emerged provide a template for discussions with other provinces and special areas.

- **Recommendation 1:** The government should give high priority in the IBIS to ongoing on-farm water management (OFWM) initiatives (e.g., laser leveling, selective lining of watercourses, pressurized irrigation systems) by the Punjab Agriculture Department and to strengthening farmers’ organizations and water users’ associations (WUAs) (supported by 93% of participants).
- **Recommendation 2:** The government should bid concessions (to private operators) for new systems that foster innovative and demand-based management of new irrigation commands with the provision that small farmers are included in the value chains (supported by 79% of participants).
- **Recommendation 3:** The government should contract one or more of the canal commands (from the barrage to the tail-end distributary) to private sector operators to improve management and deliver water entitlements reliably and transparently (supported by 72% of participants).

These recommendations were shared with stakeholders in other provinces, and specific actions were identified for AJK, Balochistan, FATA, Gilgit-Baltistan, KP, Punjab, and Sindh. Groundwater management, spate irrigation, and energy were integrated into the recommendations to form the following action plan.

Action Plan

Three priorities for action were selected in consultation with all stakeholders in the provinces and special areas based on their willingness and capacity to implement them and on the ecological advantages they would offer. They are outlined in Table A2.2 and are shown in Figure A2.5. In the provinces, the three will be phased in except in Punjab where they can be imple-

mented simultaneously. Two priorities were selected for each of the special areas (AJK, FATA and Gilgit-Baltistan).

Table A2.2: Priorities for Action in the Provinces and Special Areas

Provinces	Priority Actions		
	Continued Investment in Improved OFWM in All Irrigated Areas (OFWM) (1)	Pilot Programs for Public-Private Partnerships for High-Performance Agriculture in New Small/Medium-Sized Dams, Spate Irrigation and Greenfields (2)	Innovations in Managing Main and Branch Canals in the IBIS (3)
Punjab	<ul style="list-style-type: none"> a. Irrigation and water productivity interventions b. Sprinkler/drip irrigation and energy nexus c. Concurrent management and efficient use of groundwater 	<ul style="list-style-type: none"> a. Contract management to private operator for integrated management of watershed, reservoir, and canal network b. Innovative development of command area c. Concurrent management of surface and groundwater d. Efficient use of shallow groundwater e. High efficiency and high-tech farming f. Income diversification 	<ul style="list-style-type: none"> a. On a pilot basis, contract management of one main canal to private operator that can modernized it b. Strengthen farmers' organizations and WUAs, including via links to private sector c. Equitable and transparent distribution of water d. Cooperative management and efficient use of groundwater e. High efficiency high-tech farming f. Links with public-private partnerships
Sindh	<ul style="list-style-type: none"> • 'a', 'b' and 'c' same as Punjab • Concurrent management and efficient use of shallow groundwater using skimming wells and rationalization of surface water supplies 	<ul style="list-style-type: none"> • Same as Punjab 	<ul style="list-style-type: none"> • Same as Punjab
Khyber Pakhtun Khwa	<ul style="list-style-type: none"> • 'a', 'b' and 'c' same as Punjab • Spate irrigation 	<ul style="list-style-type: none"> • Same as Punjab 	<ul style="list-style-type: none"> • Same as Punjab
Balochistan	<ul style="list-style-type: none"> • 'a', 'b' and 'c' same as Punjab • Management and efficient use of groundwater: diesel tube wells and karez (qanat) • Spate irrigation 	<ul style="list-style-type: none"> • Same as Punjab 	<ul style="list-style-type: none"> • Same as Punjab
Gilgit-Baltistan	<ul style="list-style-type: none"> • 'a', 'b' and 'c' same as Punjab 	<ul style="list-style-type: none"> • Same as Punjab 	
FATA	<ul style="list-style-type: none"> • Same as Gilgit-Baltistan 	<ul style="list-style-type: none"> • Same as Gilgit-Baltistan 	
AJK	<ul style="list-style-type: none"> • Same as Gilgit-Baltistan 	<ul style="list-style-type: none"> • Same as Gilgit-Baltistan 	

Source: WSTF and stakeholders

Recommended Action 1: Continued Investment in Improved OFWM in All Irrigated Areas (OFWM)

The provincial directorates for OFWM have sought to improve water management on the farm and have been very successful at it. Their programs have promoted precision land leveling, watercourse lining to reduce seepage losses, and more efficient ways to apply water to the land than flood irrigation. Many of these services are now being provided through the private sector. As part of the 2004–2010 National Program for Improvement of Water Courses, Balochistan and KP completed all targeted watercourses (Balochistan 13,466 and KP 10,000) by 2008 and Sindh and Punjab achieved 100% in 2010.

Another program with great potential is Resource Conservation Technology which promotes the use of zero-tillage technology for seeding, the bed and furrow method of water application instead of flooding, and the use of crop residue as a mulch to conserve soil moisture.



Figure A2.5: Priority Actions in Specific Areas
Source: WSTF and stakeholders

Now these three have been integrated into one operation with the adaptation of the Australian zero-till bed-planter.

Strong as the support for current OFWM is, the WSTF recommends that the next round of investments go one step further in terms of institutional arrangements. This OFWM-plus approach recognizes that public-private partnerships will be most effective in implementing this next generation of integrated and sequenced interventions.

Two desired overall outcomes are enhanced water productivity and enhanced participation of water users and their institutions (Table A2.2). Specific outcomes are the following:

- reduced waterlogging upstream and salinity downstream due to less water loss ultimately resulting in balanced use of groundwater;
- savings in labor, fertilizer, and energy needed for pumping groundwater;
- increased cropping intensity and/or enhanced on-farm water productivity; and
- improved capacity of farmers' organizations and WUAs to invest in irrigated agriculture.

A long list of interventions was identified by the stakeholders whereby two or three priority interventions were selected for implementation using an integrated approach (Table A2.3). Provincial OFWM directorates and private-sector service and supply companies will be responsible for implementing OFWM initiatives. The private-sector companies will provide and install farm irrigation systems (sprinkler and drip irrigation) and services (Laser land leveling, bed-furrow irrigation) while OFWM units within the provincial irrigation and drainage authorities (PIDAs) will be restricted to executing projects to be implemented by farmers' organizations and WUAs.

Table A2.3: Desired Outcomes and Priority Interventions for Recommended Action 1

Desired Outcome	Responsible Institutions	Priority Interventions (Short List)	Long List of Interventions
Enhanced Water Productivity	Provincial Directorate of OFWM	<ul style="list-style-type: none"> Watercourse improvement and selective lining. Laser land-leveling and bed-furrow irrigation. Sprinkler and drip irrigation. 	<ul style="list-style-type: none"> Watercourse improvement and selective lining Laser land-leveling Bed-furrow irrigation Zero-till planting Sprinkler and drip irrigation On-farm water storage Cooperative management of surface and groundwater Efficient use of groundwater High-value agriculture
Enhanced participation of water users and their institutions	PIDA farmers' organizations OFWM units WUAs	<ul style="list-style-type: none"> Strengthening and restructuring of farmers' organizations and WUAs. Linking farmers' organizations and WUAs with private sector companies for services and supplies. 	<ul style="list-style-type: none"> Strengthening of FOs Restructuring and strengthening of WUAs Capacity building of FOs and WUAs Linking farmers' organizations and WUAs with private sector companies for services and supplies Demonstrations arranged by farmers' organizations and WUAs Training farmers Income diversification for farmers

Source: WSTF and stakeholders

Political Willingness

The agricultural water productivity team is of the opinion that there is strong political will in all provinces and special areas as their members of parliament have sponsored OFWM schemes with their development funds. These funds are provided as matching grants with farmers sharing up to 50% of the cost. Similar grants were provided in Sindh for center-pivot sprinkler irrigation systems. OFWM initiatives are very popular in rural Pakistan, but government financial resources are limited for scaling-up interventions.

Improving Water Productivity in Watercourse Commands

The suggested steps are the following:

- Select one distributary channel at the head, one at the middle, and one at the tail of a selected canal in consultation with PIDAs and farmers' organizations
- Develop a request for proposals to register private sector companies to provide integrated services and supplies to farmers. The former Ministry of Food and Agriculture had one that could be adapted by provincial governments.
- Design an irrigation network for a farm on a watercourse command including Laser land leveling and a layout for channels and fields considering water, soil, and crop preferences for optimizing net returns.
- Suggest cropping patterns based on comparative advantages and farmers' preferences, balanced inputs, and best practices on the farm.

- Assess the availability and application of water on the farm (nacca command) on increased cropping intensity, reduced labor, and enhanced water productivity.

Time Frame, Estimated Costs, and Cost Sharing by Partners

One year is required to develop the methodology and pilot testing for the integrated implementation of the OFWM initiatives. A total of 5 years is required to cover whole canal command. The provincial governments are willing to share part of the cost in addition to those shared by the WUAs and/or farmers. Farmers' share in cash is expected to be in the range of 10%–50% depending on the type of intervention with an average of 30%. In the past, the provinces have contributed 20% to projects which can be increased to 30% considering the devolution of the agriculture sector and the higher priority assigned to water productivity. Thus the Friends of Democratic Pakistan (FODP) is expected to contribute 40% of the project cost to cover part of the investment cost and the full cost of technical assistance, training, and building institutional arrangements and mechanisms. The estimated cost of the program is \$300 million in Punjab, \$100 million in Sindh, and \$50 million each in KP and Balochistan. In addition, \$20 million is the estimate for AJK, FATA, and Gilgit-Baltistan. The total estimated cost of the proposed program is \$560 million with an FODP share of \$224 million. The provincial governments and farmers will share \$168 million each.

Recommended Action 2: New Public-Private Partnerships for Stimulating High-Performance Agriculture in New Irrigation Schemes

Small and Medium-Sized Dams and Spate Irrigation

There is a huge potential for developing new irrigation commands outside the IBIS by constructing small/medium-sized dam though many such projects in the last 3 decades have performed quite poorly because the command area developed in most of the dams is only 50% of the designed area largely due to faulty canal design by PIDs and to poor construction of watercourses by farmers in the undulating terrain. In addition, basic services like precision land leveling—a pre-requisite for surface irrigation—are often not available. Water conveyance losses in the canal network are as high of 50%, and the reservoirs are silting up as watershed management was never part of small dam projects. On top of all that, there is a complete lack of efforts to assist farmers with OFWM practices.

It is entirely feasible to reverse this trend and make these areas into high-productivity systems as was done in Egypt. This is an area where the private sector can play a major role including in dam construction and delivering water to users. Water can be delivered to farms via pipes to be used more efficiently through drip and sprinkler irrigation. Unlike the IBIS, private developers could control the free rider problem and get properly paid for their services. The PIDs could bid out concessions to the private sector to develop and manage these schemes. In the Lahore workshop there was strong support for a major role for the private sector in building and operating small dams (as is done in Brazil). In the follow-up consultations, all provincial governments and private sector representatives identified medium-sized/small dam development as an appropriate area for the private sector. The recommendation was even made to allow private operators to diversify their incomes through integrated land use including aquaculture. This broad consensus bodes well for the future of this model in Pakistan. The stakes are very high because of the wealth and welfare that can be generated in these specific projects but also because success here will (as in Egypt) put pressure on the “old system” to reform and to start producing like the “new areas” are producing.

The provincial government has to walk a fine line. On the one hand there is a need for action and for results, and there are private operators ready to go (e.g., Valley Pakistan) that are already developing a framework for engaging small holders in a farmers' cooperative. Corporate culture will then be integrated into the value chain, diversifying incomes, and managing the dam and irrigation network. On the other hand, there is a long history in many countries of great initial hopes that were dashed because preparation was insufficiently careful, and the whole idea was eventually dropped.

The WSTF therefore recommends that provincial governments that want to move in this direction (i) pay attention to lessons learned and make sure that they have the proper public architecture and contractual arrangements in place; (ii) that they do this with a sense of urgency and impatience to get action and results; but (iii) that they not cut corners, because short cuts will prove to be long cuts! Any public-private partnership must recognize the different roles played by government, shareholders, and users and develop a practical and balanced regulatory framework. It is important, too, to understand that there is a wide range of depth of private sector involvement (and corresponding public sector involvement) from simple service contracts, to management contracts, to leases, to concessions, to full privatization. Smart institutional design for high performance must take into account the risks for each party and assign them to those most able to bear them. The design must also be dynamic with ever-deeper forms of private sector involvement as the process matures.

The WSTF also recommends that committed chief ministers use the following procedure to develop public-private partnerships for building small/medium-sized dams and developing the commands of existing and new ones.

- The provincial government manages the process with the chief minister playing a prominent role.
- The government procures technical assistance from a development partner with extensive experience with private sector participation in infrastructure (such as the Water Resources Management Group) to:
 - review lessons learned with contractual forms in other countries paying particular attention to ways in which they dealt not just with water services but also with providing complementary credit, seeds, technology, best practices, marketing, and watershed management;
 - send political leaders, government officials, local private sector operators, and farmers to visit relevant successful cases;
 - develop a transparent process for the effective participation of the private sector that defines the key elements of a legal and regulatory process, the capacity to be built, and the options for forms and that encourages participation by government, the private sector, farmers, and civil society (guidelines developed by the Ministry of Finance have been adjusted and can be used as a template); and
 - present options for different forms of public-private partnerships for the chief minister to consider.
- Get assistance from one or more capable development partners to put in place the institutions necessary for managing this process, for financing start-up costs (public financial contributions to the public-private partnerships), and for developing the capacity of the farmers' organizations.
- Decide where the initial contracts are to be issued giving priority to areas where the probability of success is relatively high.
- Monitor, evaluate, and adjust both the initial contracts and the overall program.

New Canal Irrigation Schemes for Innovative Agriculture

Currently, KP and Balochistan are not in a position to utilize the water they are entitled to in the 1991 accord. KP's allocation is 8.78 MAF but only 6 MAF are utilized in an average year, and 4.23 MAF are allocated to Balochistan that on average uses only 2 MAF. This under-utilization is due to the lack of adequate infrastructure to divert the water. The real question is who is using this water? The accord currently does not permit provinces to auction surplus waters though this may change, but starting a water market may deprive smaller provinces of their entitlements which may not be fair in the long run. The PRs 7.0 billion subsidy for tube wells in Balochistan could instead be used to build new infrastructure for surface irrigation in the most depleted aquifers.

The other aspect that needs consideration is developing infrastructure in KP (i.e. China Road and Bridge Corporation lift schemes #1, #2, and #3) and smaller schemes for Balochistan using lift irrigation. Otherwise extending a canal to increase water utilization will end up increasing inefficiency in conveyance while enhancing capacity through remodeling will result in increased waterlogging (e.g., the Pat Feeder Canal in Balochistan). Another option is to use the experiences of sunken canals in Egypt and let farmers pump when there is a demand as per their allocations. Lift irrigation schemes in the public sector will be a burden as farmers will not be ready to pay the cost of pumping which will be many times higher than gravity flow schemes as the recovery of abiana is around 15% in Balochistan and may be around 50% in KP. The concept of sunken canals and developing cascades of reservoirs for aquatic food resources has been successful in Sri Lanka and Thailand (aquatic food resources include fish and aquatic food plants). A sunken canal system also has the advantage of managing waterlogging as the water table will stay lower than the water level in the sunken canal but at the same time will generate a new aquifer in the fragile environments of Balochistan and southern KP.

Desired Outcome

The desired outcome is higher agricultural productivity through the reliable, transparent, and equitable distribution of water stored by small/medium-size dams, spate irrigation and Green-field projects (Table A2.4). The specific outcomes are the following:

- increased command area, increased cropping intensity, and enhanced water productivity ultimately for the whole command;
- improved management of watershed and rangelands providing feed for livestock and fuel wood, i.e., translating watershed management into livelihoods; and
- improved capacity of farmers and farmers' organizations to continue investing in irrigated agriculture and reduce their dependence on subsidies, i.e., a demand-based system for doubling productivity.

A long list of interventions was identified by stakeholders, six of which were selected to implement using an integrated approach (Table A2.4).

Four institutions are responsible for implementing the interventions: (i) PIDs; (ii) PIDA small dam organizations; (iii) provincial agriculture departments' OFWM units; and (iv) private operator under public-private partnerships. A private operator will take over the management of small/medium-sized dams, the integrated watershed, the reservoir and command area, and distributing water and enhancing productivity. The role of PIDs, PIDAs and OFWM units will be restricted to effective and efficient execution and farmers' organizations, WUAs, and private operator would take over the role of managing the system and providing services.

Table A2.4: Desired Outcome and Priority Interventions for Recommended Action 2

Desired Outcome	Responsible Institutions	Short List of Interventions	Long List of Interventions
Higher agricultural productivity through reliable, transparent and equitable distribution of water in a selected Small/ Medium Dams and Spate Irrigation Schemes	<ul style="list-style-type: none"> • PID • PIDA Small Dam Organizations • Provincial agricultural department OFWM units • Private Operator under a public-private partnership 	<ul style="list-style-type: none"> a. Management contract with private operator and links with private sector supply and service companies b. Integrated management of small/ medium-sized dam and/or spate irrigation scheme c. Integrated watershed management and command area development d. Cost-effective and transparent operation and maintenance of dam and canal network or spate irrigation e. Concurrent management and efficient use of shallow groundwater f. High-value and high-tech agriculture 	<ul style="list-style-type: none"> a. Management contract with private operator b. Integrated management of small/ medium-sized dam and/or spate irrigation scheme c. Integrated watershed management and command area development d. Cost-effective and transparent operation and maintenance of dam and canal network e. Concurrent management of surface and groundwater f. Efficient use of shallow groundwater g. Water and energy use efficiency h. High-value and high-tech agriculture i. Links with private sector supply and service companies

Source: WSTF and stakeholders

Political Will

The team is of the opinion that there is a strong political will in Punjab and a desire in other provinces to double or triple productivity of small/medium-sized dams as they can be operated on demand and their ecological advantages allow high-efficiency irrigation and high-tech agriculture. There is a presidential directive that high-efficiency irrigation and high-equilibrium farming systems should be introduced in the command areas of all new dams. PARC has also been directed to take responsibility for water management and for enhancing productivity. Spate irrigation schemes also provide opportunities for enhancing agricultural productivity through improved management of spate flows. Members of parliament from Balochistan, KP and southwestern Punjab have demonstrated strong will and support as they contributed their development funds to rehabilitate spate irrigation schemes. Nevertheless, available resources are limited and the priority assigned for funding is low.

Developing the Commands of Small Dams

The suggested steps are the following.

- Select a dam to formulate plans for integrated development and contract its management to a private sector operator for 10 years.
- Develop a request for proposals to select a private sector operator to manage small dams, command areas, and stored water specifying the responsibilities of government, existing institutions, farmers' organizations, farmers, and the private operator. The contract would also include improving the physical condition of the irrigation network, aquaculture, water measurement and distribution, and operation and maintenance guidelines.
- Develop links with the private sector to install drip/sprinkler irrigation, to manage reservoir operations and aquaculture, and to provide inputs.
- Develop institutional mechanisms for managing small dams, reservoirs, and command areas in terms of services and routine operations and maintenance.
- Develop and implement a system to provide water to farmers on demand.
- Enforce mechanisms for using stored water along the periphery of the dam using fractional pumping systems coupled with drip irrigation for orchards.
- Provide training and capacity building for farmers' organizations.

Managing Spate Irrigation and Farming

The suggested steps are the following:

- Select spate irrigation schemes for integrated development and management with the active participation of communities and contract management to private sector operators (as service providers) for 10 years.
- Develop a request for proposals to select private operators to manage the schemes and regulate water specifying the responsibilities of the provincial government (including the power to settle conflicts), existing institutions, farmers' organizations, farmers, and private operators.
- Organize and train communities to take over the role of business institutions.
- Develop links with private companies to provide services and supplies for oilseed production, organic farming, and, in combination with shallow groundwater, high-value horticulture.
- Develop institutional mechanisms for the long-term management of spate irrigation, watersheds, and command areas in terms of services and routine operations and maintenance. This requires restocking the earth moving equipment (bulldozers, front-loaders) needed to construct earthen diversions and guide bunds and establishing private sector institutional mechanisms for continued service delivery.
- Develop and implement an equitable water distribution system based on codified water rights to reduce conflicts as development expands (including judicial powers)
- Introduce command area works and water distribution in new and existing areas following successful examples by PARC in field intakes, distribution structures, and field overflow structures.
- Invest in new infrastructure suitable for spate irrigation diversion (bed stabilizers, permeable spillways, reinforced embankments, and recharge weirs) to secure the system and develop additional functions of spate irrigation such as ponds for livestock.

Managing New Canal Irrigation Schemes for Innovative Agriculture

The suggested steps are the following:

- Select new canal irrigation schemes (sunken canals) and large lakes for integrated development and management of water and high-tech farming with the active participation of WUAs and contract management to private operators for 10 years.
- Develop a request for proposals to select a private operator to manage the scheme and regulate water in sunken canals and large lakes specifying the responsibilities of the provincial government, existing institutions, farmers' organizations, farmers, and private operators.
- Organize farmers' organizations and WUAs so that they take over the role of business institutions for developing innovative irrigation from sunken canals and aquatic food resources in large lakes.
- Develop links with private companies to provide services and supplies to develop the potential of the sunken canals for high-tech farming and large lakes for aquatic food resources to develop new shallow groundwater aquifers for high-value horticulture, especially in areas with non-perennial commands to ensure the year-round availability of water.
- Develop institutional mechanisms for the long-term management of sunken irrigation canals, large lakes, and command area in terms of services and routine operations and maintenance.
- Introduce command area works in sunken canals and innovative farming in large lakes or cascades following successful examples in Egypt, Sri Lanka, and Thailand.
- Invest in new infrastructure suitable for sunken canals using shallow lift irrigation schemes in KP and Balochistan to provide new livelihoods for the unemployed.

Time Frame, Estimated Cost and Cost Sharing by Partners

One year is required to develop the methodology and pilot test the innovative management of commands of small/medium-sized dams and spate irrigation by private operators, farmers' organizations, and farmers. A total of 5 years is required to cover whole command and to build the capacity of the staff of the private operator, farmers' organizations, and WUAs. Linking farmers' organizations and WUAs with the private sector service and supply companies will help to provide inputs and to sell marketable products.

The average cost estimated for a small and medium-sized dam project is \$20 million for integrated development and management. The average cost of constructing, developing, and managing a spate irrigation scheme is also estimated at \$20 million including the construction of critical infrastructure. The actual cost per scheme will vary based on the size of the command area and the availability of water. In all, 23 small/medium-sized dams are suggested (5 each in Punjab, KP, and Balochistan and 2 each in Sindh, AJK, FATA and Gilgit-Baltistan) at a total cost of \$460 million with an FODP share of \$276 million (60%). The provincial governments will share \$138 million (30%) and farmers will contribute \$46 million (10% of project cost or 30% of productivity enhancement interventions).

In addition, three spate irrigation schemes each in KP, Punjab, Sindh, Balochistan, and FATA are suggested. The cost for all 15 is estimated at US \$300 million with an FODP share of \$180 million (60%). The provincial governments will share \$90 million (30%), and farmers will contribute \$30 million (10% of project cost or 30% of productivity enhancement interventions).

Action Area 3: Innovations in Managing the Main and Branch Canals in the IBIS

Over the last 15 years there have been a series of reforms (the PIDAs reforms) aimed at improving the quality of water delivery services in the IBIS. Some have worked well and some have not, in part because of an idealized conception of the ways in which networked services can be provided.

Networked services can be provided through a combination of formal and informal institutional arrangements. Whether a formal or informal arrangement works best on any particular part of the network depends on its technical complexity and transaction costs. At one extreme it is obvious that a WUA cannot manage the construction and management of a barrage as this requires formal, technical organization in all systems. At the other extreme, on a watercourse the most challenging aspect is not technical but cooperative management by users. At this end of the spectrum, farmers' organizations are more effective than a government organization. The PIDA reforms correctly identified farmers' organizations/WUAs as key at the bottom end of the spectrum. For the most part, they have worked fairly well, and there is broad concurrence that this part of the reform model should be maintained. The major problem highlighted during field visits, consultations with farmers' organizations, and the Lahore workshop was the lack of predictability and accountability in the next level up in the network where the task is managing branch and main canals. The PIDA model required an organization of farmers' organizations—an AWB—to manage canals. This has not worked well, and it now is clear that this is a step too far for an informal organization.

A key question is then, what form of formal organization is appropriate to manage the main and branch canals? Consultations with farmers' organizations and the Lahore workshop concluded that it is worth trying a new arrangement: contract a private canal operator and offer performance incentives to deliver water according to entitlements in a predictable way to the

farmers' organizations. In this system, the IPDs would continue to operate the barrages, private operators would operate the main and branch canals, farmers' organizations would operate the distributaries, and WUAs the watercourses. What is essential is that the entitlements at each level are clearly established; that there are measurement structures at each interface; and that there are trusted, transparent measurements and reports of entitlements and deliveries. The on-line system in Punjab that has been in place for the last 7 years and posts this information bi-weekly is a tremendous advance and should be universal in the IBIS.

What might such a service cost, and how would a private operator be paid? Using current institutional arrangements to operate and maintain the irrigation system, an asset management planning exercise by the Government of Punjab showed the breakdown of costs from the dams to the watercourse. The overall cost of operations and maintenance is \$100/hectare with roughly 20% of costs attributable to dams, 8% to barrages and head works, about 43% to main canals and link canals and 25% to distributaries and minors. It is likely that this cost is both too low (because it does not include the costs of rehabilitating assets) and too high (because the PID is not an efficient supplier of services). Would users be willing to pay \$40/hectare/annum (PRs3500) for a high-quality water service? The answer is to phase in the approach and in the beginning focus on increasing the recovery of abiana to nearly 100%. During this period, the government may subsidize the operation and maintenance costs of the private operator. After increasing abiana recovery and providing effective services, the abiana can be increased gradually over a period of 5 years.

It is important to note that there is a de facto market test of the willingness to pay for a high-quality service since farmers currently pay for pumping groundwater to irrigate wheat five times per crop at a cost of PRs1000/acre for a total of PRs5000/acre using diesel-operated tube well pumps (87% of all tube wells in the country). This suggests that farmers could and would (if the incentives for both the service provider and farmers were right) be willing and able to pay the cost of PRs3500/hectare/annum (PRs1417/acre/annum) for a reliable water service. It should also be noted, however, that payments could by no means be taken for granted. Current abiana rates are on the order of PRs334/hectare/annum (PRs135/acre/annum) in Punjab, or 1% to 4% of the value of a good supply of water, and still collection rates are very low.

Initially the canal operator would therefore be paid by an external source (the government or a donor) so that there are sufficient resources to improve the system and to operate it effectively and transparently. An important element of the relationship between the private operator and the farmers' organizations would be to make it clear that as service improves, the organizations will pay the operator according to an agreed schedule in order to move away from subsidies over a specified period.

It is well understood that contracting a private operator would be an experiment that would take all parties into uncharted waters. Accordingly it is recommended that such a program be very carefully designed by professionals who have extensive experience with public-private partnerships. The Government of Brazil hired the International Finance Corporation as investment advisors for a similar undertaking. The terms of reference for the advisors would be to design the legal, regulatory and operational elements of the contract. The procedure for making the design is the following:

- Assess the political will at high levels to lead such an approach.
- Review the experience of similar efforts in irrigation and other services around the world.
- Start with a canal where there are pre-conditions (including enlightened farmers, good

logistics, and well-established agricultural support services) for rapid growth in high-value agriculture.

- Assess the appetite of the local private sector for engaging in the contract (with global experience showing that successful efforts of this sort are led by local firms with international companies often playing important roles as part of a consortium but not in the lead).
- Assess the appetite of farmers' organizations to work with a bulk supplier.
- Assess the political, natural, and commercial risks of the arrangement and design a structure that assigns the risks to the parties that can most appropriately bear them.
- Design a contractual form that will meet the objectives of the various parties;
- Design a regulatory structure to monitor the contract and make the adjustments that are always necessary in a new arrangement.
- Engage with donors to ensure financing during the critical period of about 5 years when revenues from users will not be sufficient to cover the costs to the service provider.

Discussions at the Lahore workshop showed that there was little familiarity with such a contractual form but that given the importance of reforms in canal operations to the productivity of the IBIS, the participants considered it was worth exploring such an arrangement. The chief minister of Punjab and his key secretaries understand the significance of such reforms to the productivity of the system, and he has strong support in proceeding from enlightened farmers in the province. Similarly—but not at the same level—officials in KP and Balochistan indicated interest in pursuing such an approach.

Donors have two key roles to play in helping fund this initiative. First, the one-off costs of hiring transaction consultants to design the contract are high, and the province will need support from something like the new Water Resources Management Group or a conventional donor. Second, assuming that a contract emerges, there is a vital role for donors to play in financing the wedge so that the system can make the transition to high performance and financial viability. This support is also crucial in the IBIS as the energy crises in the country will have a large impact on the use of pumped groundwater. To maintain food security, the nation needs to pilot this experiment with donor support.

The desired outcome is higher agricultural productivity through reliable, transparent, and equitable distribution of water in a selected canal command. The specific outcomes include the following:

- ensure volume and equitable distribution of canal water including the downstream reaches;
- no major increase in groundwater use where it is under stress;
- reduced waterlogging in the upstream reaches and controlled salinity in the downstream reaches of the canal commands;
- increased cropping intensity and enhanced water productivity in the canal commands;
- savings in the labor and energy costs associated with groundwater pumping; and
- improved capacity of farmers and WUAs to continue investing in irrigated agriculture and to make it a self-sustaining enterprise.

A long list of interventions was identified by the stakeholders, and six were selected for implementation (Table A2.5). Four institutions are responsible for implementing the interventions: (i) PIDs; (ii) PIDAs; (iii) provincial agriculture department OFWM units; and (iv) private operators under public-private partnerships. A private operator will take over the management of one main canal command as a pilot project including distributing water, operations and maintenance, and providing services and supplies to enhance productivity in collaboration with farmers' organizations and WUAs.

Table A2.5: Desired Outcome and Priority Interventions for Recommended Action 3

Desired Outcome	Responsible Institutions	Short List of Interventions	Long List of Interventions
Higher agricultural productivity through reliable, transparent and equitable distribution of water in a selected canal command	PID PIDA provincial agriculture department OFWM units Private Operator under public-private partnership	<ul style="list-style-type: none"> Strengthen farmers' organizations/ WUAs Management contract with private operator and links with private sector supply and service companies. Modernize canal commands including the use of information technology, decision-support systems, and cost-effective operation and maintenance. Concurrent management and efficient use of groundwater. Efficient use of water and energy High-value and high-tech agriculture 	<ul style="list-style-type: none"> Management contract with private operator Resolve issues related to PIDA/PID and AWBs, Private operator takes over management Innovative modernization of canal command Cost-effective operation and maintenance of canal network Concurrent management of surface and groundwater Efficient use of shallow groundwater Efficient use of water and energy High-value and high-tech agriculture

Political Will

As per the 1997 PIDA acts, farmers' organizations are now well established in the pilot AWBs in Punjab and Sindh, whereas WUAs (based on WUA acts of the 1980s) are well-known institutions all over the country. The issue is whether to continue the AWBs in Punjab and Sindh as the PIDs in the provinces are not interested in transferring all of the canals to the PIDs. There seems strong political will in Punjab to pilot test a private operator in one of the canal commands because state-of-the-art improvements are needed to achieve the vision of the chief minister of making Punjab into a regional super power in agriculture. Sindh may wait for Punjab to decide and then may pilot test a private operator on one of their canals. The modus operandi would depend on the willingness, political will, and realities in the provinces, so the model will evolve according to circumstances. Regarding the remaining canals, the team is of the opinion that the PIDs should continue the successful institutional reforms and strengthening farmers' organizations and WUAs as part of recommended Action 1.

Managing a Canal

- Select a main canal command to be managed by a private operator under contract for 10 years.
- Develop a request for proposals to select a private operator to manage the canal and regulate water at the distributary head specifying the responsibilities of the provincial government, existing institutions, farmers' organizations, farmers, and private operators. The contract should also include improving the physical condition of canal network and water measurements and developing guidelines for operations and maintenance.
- Develop a water measurement network at the main and distributary canals, mogha, and the watercourse to establish conveyance loss and incorporate it in the warabandi formula.
- Design a farm water conveyance and application system, a cropping pattern based on comparative advantages and farmers preferences, and balanced inputs and best practices for doubling net returns.
- Assess the impacts of the availability of water on increased cropping intensity, higher crop yields, and enhanced water productivity.
- Train farmers' organizations and WUAs in the equitable distribution of water in disty and mogha commands.

Time Frame, Estimated Cost, and Cost Sharing by Partners

One year is required to develop the methodology and pilot test for a private operator to manage a canal command. A total of 5 years is required to cover the whole canal command and to build

the capacity of the private operator and of representatives of farmers' organizations and WUAs. Training farmers in productivity enhancement is also an essential part of the project. Linking farmers' organizations and WUAs with private sector service and supply companies will help to provide inputs and sell marketable products.

Estimates for the cost of the pilot scheme include critical infrastructure to regulate water conveyance and delivery, water measurement structures and equipment, improvements in the water conveyance and delivery system, and enhancing water productivity for irrigated agriculture. In Punjab and Sindh the cost is \$175 million each; in Balochistan \$100 million; and in KP \$50 million. Thus the total estimated cost of the four pilot projects is \$500 million with a share of \$300 million (60%) from development partners. The provincial governments will share \$150 million (30%) and farmers will contribute \$50 million (10% of project cost or 30% of productivity enhancement interventions). The variation in the cost for the four pilots is largely due to the variation in the sizes of the canals.

Strategic Framework for Implementation

Developing a Revised Strategic Framework

The revised strategic framework is based on the visions of the political leadership in the provinces. The vision of the Chief Minister of Punjab has to be translated into a strategic framework of actions moving towards high-equilibrium, irrigated agriculture. The proposed action plan is driven by the following strategically important considerations.

- Involve the private sector and farmers' organizations as much as possible in development and management.
- Follow the philosophy that better management will result only when the delivery of irrigation water is linked to farmers' production. Only then will farmers value the service and be willing to pay for it.
- Canal water delivery must be priced appropriately and assessments must be collected to adequately finance operations and maintenance.

Strategy

The strategy for implementing the recommended actions and priorities must be based on the capacity and willingness of the provinces and on their realities. In Punjab, the implementation of all the three recommended actions can be initiated as there is political will and committed leadership whereas in the other provinces the need for innovative management of canal commands and small dams must be reinforced. Investments in OFWM can be continued in the provinces and special areas as there is both capacity and willingness; however, they have to be planned and implemented in an integrated fashion to move towards medium-equilibrium systems. This intervention will have larger impacts in a relatively short time.

Implementing Priority Actions

In Balochistan and KP, the pilot AWBs implemented under the 1997 PIDA reforms have been discontinued. Irrigation sector reforms as per 1997 acts were implemented in three and four pilot AWBs in Punjab and Sindh, respectively, and the rest of the canals are managed by the PID. The current action plan provides a broader framework, and further studies might be required to formulate detailed action plans while formulating and appraising the investment projects.

Engaging the Private Sector

This is the most important element of the strategic framework, especially for the actions related to innovative management of small/medium-sized dams, spate irrigation schemes, and main/branch canals in the IBIS. A private operator will be responsible for management, for operations and maintenance, and for developing critical physical and institutional interventions for converting the low-equilibrium system into a high performance system that can support high-productivity agriculture. This is a new approach to irrigation management and would require a pilot intervention to establish the proper formula in each case. Technical backstop support would be essential while formulating the specific investment projects.

Involving the private sector in the innovative management of canal commands, though potentially beneficial in the long run, will be a challenge even in Punjab where the leadership is more committed. The example of Brazil is worth considering, and appropriate implementation mechanisms need to be adapted to suit realities. Irrigation ditch companies in the western US are non-profit organizations of water users that also provide insights for developing the case for a private operator because they operate in a corporate culture. They manage relatively smaller canals with discharges averaging 300–500 cubic feet/second compared with the canals in Pakistan with discharges of more than 1500 cubic feet/second; therefore initial pilots may be implemented in relatively smaller, more manageable canals. The real question is whether Pakistan should continue the AWBs, or should PIDs manage canals where reliability, equity, and transparency in the distribution of water are questionable. The farmers at the tail-end are receiving 50% to 33% of water per unit of time compared to the farmers at the head; this is also a cause of waterlogging and salinity in the canal commands. The private sector can do at least that well.

Financing and Operation and Maintenance Costs

Irrigated agriculture is now fully the responsibility of the provinces though water is still in the federal domain. The recovery of the abiana has to be improved in a gradual manner so that costs for improving irrigation and agricultural productivity can be reduced in the near future. For the time being, the public sector has to bear the cost of operations and maintenance due to the poor recovery of abiana. The involvement of the private operator would help to improve the financial situation after 5–7 years when full operation and maintenance costs can be recovered and linked with a high-performing irrigation system.

The FODP and other donors can provide critical support for making this shift happen leading ultimately to a “build-maintain-manage” irrigation system at high-equilibrium and to improved performance of irrigated agriculture by doubling productivity. Farmers will pay the higher abiana rate if it is linked with a reliable, transparent, and equitable supply of irrigation water. The donors can provide knowledge and technical assistance and part of the investment cost depending on the capacity and willingness in the provinces.

Recommended Actions for Pakistan

Federal Government

- Formulate policy reforms for joint implementation of water and agriculture programs in the IBIS using the irrigation command as a unit. This would require a policy for effective coordination of departments of irrigation and agriculture under the leadership of chairman/additional chief secretary, planning and development in the provinces.
- Formulate policy reforms for contracting the management of the irrigation command

to a private operator using the framework of standard operating procedures for public-private partnerships already developed by the Ministry of Finance and the draft request for proposals in the background paper on the role of the private sector.

- Ensure the implementation of the strategy and action plan developed by the WSTF through unbundled projects in various provinces and special areas considering their realities, the capacity of the provincial institutions, and political will.

Balochistan Government

- Formulate and appraise projects considering systematic and comprehensive planning, realities, and priorities.
- Seek funds considering the capacity and willingness of public sector institutions and the private sector. Start with OFWM followed by small/medium-sized dams and spate irrigation and finish with innovative management of canals in the IBIS.
- Groundwater management and efficient use of water and energy must be an integral part of all the schemes planned and implemented.

KP Government

- Formulate and appraise projects considering systematic and comprehensive planning, realities, and priorities.
- Seek funds for actions considering the capacity and willingness of public sector institutions and the private sector. Start with OFWM followed by small/medium-sized dams and spate irrigation and finish with innovative management of canals in the IBIS.

Punjab Government

- Formulate and appraise projects considering systematic and comprehensive planning, realities, and priorities.
- Seek funds to simultaneously implement the three actions.
- Groundwater management and efficient use of water and energy will be an integral part of the three.

Sindh Government

- Formulate and appraise projects considering systematic and comprehensive planning, realities, and priorities.
- Seek funds considering the capacity and willingness of public sector institutions and the private sector. Start with OFWM followed by small/medium-sized dams and spate irrigation and finish with innovative management of canals in the IBIS.

AJK, FATA, and Gilgit-Baltistan governments

- Formulate and appraise projects considering systematic and comprehensive planning, realities, and priorities.
- Seek funds considering the capacity and willingness of public sector institutions and the private sector. Start with OFWM followed by small/medium-sized dams and spate irrigation.
- Groundwater management and efficient use of water and energy will be an integral part of the initiatives undertaken while implementing spate irrigation schemes.

Recommendations for FODP and Development Partners

The action plan clearly articulates priorities for provinces and special areas. Development partners may work jointly with the Ministry of Water and Power and with departments of irrigation and agriculture in provinces and special areas to formulate investment proposals. A total of 5 years is suggested for investment projects in two phases. The first phase can be for 1–2 years depending on the action addressed. Based on initial success and opportunities, a further investment of 3–4 years may be provided to complete the process.

Next Steps for Implementation

- The Ministry of Water and Power, FODP and other development partners, and government departments in the provinces and special areas should constitute a water development and management forum to implement the action plan.
- Provincial water development and management committees should be constituted by the respective planning and development departments/boards in the provinces to formulate projects and seek funding.
- The Ministry of Water and Power should appoint a full-time coordinator to implement recommended actions and undertake next steps for implementation and also provide a secretariat to support the provinces and special areas to effectively implement the action plan.
- The Ministry of Water and Power and FODP and other development partners should support an independent water forum hosted by Pakistani chapters of International Union for the Conservation of Nature to provide knowledge and policy support as an independent think tank.

Summary on Water and Agricultural Productivity

The recommendations regarding water and agricultural productivity are shown in Table A2.6. Three recommended actions and four projects were identified covering (i) OFWM-plus; (ii) public-private partnerships for small and medium-sized dams; (iii) improved management of main canals; (iv) spate irrigation; and (v) optimal but judicious use of groundwater. These projects will take 5 years (2012–2016). The total proposed investment costs total \$1.920 billion.

Table A2.6: Action Plan for Water and Agricultural Productivity

No.	Action/Project	Objective	Primary Responsibility	Time Line	Financing (US\$ million)
1.	On-farm water management	Increase agricultural productivity	Provincial agriculture departments, AJK, FATA, Gilgit-Baltistan	2012–2016	\$560
2.	Public-private partnerships for small and medium-sized dams	Increase agricultural productivity	Provincial irrigation and agriculture departments, AJK, FATA, Gilgit-Baltistan	2012–2016	\$460
3.	Improved management of main canals	Increase agricultural productivity	Provincial irrigation departments	2012–2016	\$500
4.	Spate irrigation	Increase agricultural productivity	Provincial agricultural departments, FATA	2012–2016	\$300
5.	Optimal but judicious use of groundwater	Sustainable productivity	Provincial agricultural departments, FATA	2012–2016	\$100
				Total	\$1920

Source: WSTF

Introduction¹

Considering the importance of groundwater in Pakistan, the resource is still for all practical purposes considered “a given” and is neither systematically monitored nor managed. On the one hand, this lack of management is illogical since groundwater is the largest storage reservoir in the country and should be managed as such. On the other hand, unlike a surface reservoir where there is an operator and an operating rule, for groundwater there may de facto be millions of operators of both the land and the groundwater. Effective mechanisms for operating such a large reservoir are, in Pakistan and elsewhere, extremely challenging to devise and to implement. The best openings for managing the large alluvial aquifers lie not in direct regulation but in “managing the context”, i.e. regulating surface supplies to discourage or encourage groundwater pumping, managing natural recharge and drainage, and promoting certain forms of land use and agriculture. In the smaller groundwater basins in Pakistan’s arid hills, a different repertoire of possible measures exists based on local recharge and local regulation.

Currently, much of the economy in Pakistan depends on groundwater. The water supply for major cities such as Lahore, Peshawar, and Quetta has always been dependent on groundwater, but in Rawalpindi and Karachi and many small towns, groundwater has increased as a proportion of city water supply even in the last decade. Also, many industries prefer to use the relatively clean groundwater.

Groundwater is also remarkably important in Pakistan’s agriculture in absolute quantity and in ensuring a reliable supply that is not provided by surface irrigation. Given Pakistan’s claim of having the world’s largest single surface irrigation system, the astonishing fact is that in the agricultural heartland of Punjab, an estimated 52% of the farm water comes from groundwater pumping. With the restraints on large-scale surface water development since 1976, agricultural expansion and intensification in the country has been driven to a very large extent by the development of approximately 1,000,000 private tube wells (Figure A3.1).

It is estimated that 75% of the increase in water supplies in the last 25 years is to be attributed to public and private groundwater exploitation. The investment in these private tube wells is of the order of Pakistan rupees (PRs) 40–50 billion whereas the annual benefits in the form of agricultural production are estimated at PRs250 billion, roughly equivalent to 5% of gross domestic product. The dramatic increase in groundwater pumping in the canal command areas is mirrored and even exceeded in the areas outside the commands in Balochistan Province and in the rain and flood-dependent areas of Khyber Pakhtunkhwa (KP), Sindh, and Punjab

1. A background paper on groundwater is available from the Asian Development Bank

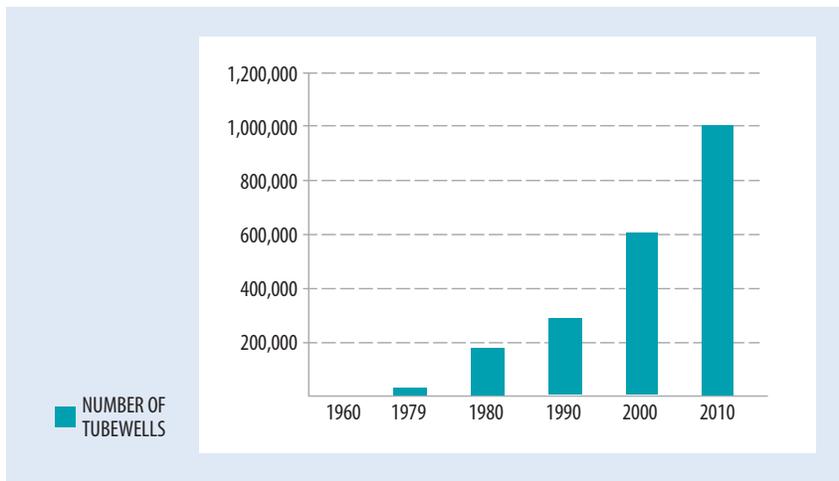


Figure A3.1 Growth of Tube Wells in Pakistan
 Source: Based on surveys by Statistics Division, Government of Pakistan.

provinces.

This spectacular success story has, however, in many respects gone too far. Overuse has, for example, come to a logical end in parts of Balochistan where the once productive, water-demanding and water-sensitive apple orchards have been dismantled in many areas in the last 10 years following drought and the depletion of groundwater. Around Quetta, the farmers who persist have started to drill tube wells inside the hard rock limestone aquifer, thus competing with the ever growing urban population that targets this same water source of last resort.

Moreover, in the canal areas of Punjab, a precarious balance of a kind now exists with recharge and discharge in balance overall and water logging all but gone from the fresh groundwater areas. The concern is that more intensive pumping will lead to the deterioration of water quality by inviting the ingress of low-quality groundwater from saline zones or up-coning from deeper saline groundwater layers.

The exception is Sindh Province. Here groundwater management is out of balance as well, but the scales are tipped to the other side. In the surface irrigation system, water allocations for canal commands are high and are further boosted by actual deliveries. Related to this, groundwater is still a small proportion of water consumption. Water logging and the resulting loss of agricultural productivity and the impact on the health of humans and livestock persists. In a large part of Sindh, water tables are in or near to crop root zones (38% and 50% respectively). The same is true in the canal commands of Balochistan especially in Kirther Canal. Table A3.1 suggests that water logging has all but disappeared from the canal areas of Sindh and Balochistan.

Table A3.1: Depth of Groundwater Tables in Canal Irrigated Areas

Depth to Water Zone in meters (m)	Punjab	Sindh	Khyber Pakhtunkhwa	Balochistan
Less than 1.5 m	6.2	38.5	5.5	20
1.5m to 3.0 m	18.9	50	25.9	32.5
3.0 to 4.5 m	29.3	6.1	12.9	22.5
4.5 to 6.0 m	14.8	2.9	9.3	17.5
More than 6.0 m	30.8	2.5	46.4	7.5
Total area irrigated in million hectares	9.96	5.74	0.54	0.4

Source: Based on ground water monitoring by the Water and Power Development Authority's Salinity Control and Reclamation Project Monitoring Organization's monitoring of mainly canal irrigated areas hence the depth of groundwater in other areas is not reflected.

Population growth and increasing demands for water for irrigation, water supply, industry, and environmental needs and at the same time the unchecked discharge of effluents into surface and groundwater bodies and sewerage leakage in urban areas make groundwater management even more important. Drought conditions from 1998 to 2003 led to acute water shortages and illustrated just how close water use is to the limit of the resource in parts of the country. A new drought period would expose an even larger vulnerability. Keeping in mind the importance of groundwater for Pakistan's food and fiber and its increasing demand in future, the sustainability of this invaluable resource is of high strategic and economic importance.

Current State of Management

For a long time, two very different policy themes dominated the agenda: (i) the control of high groundwater tables in the canal-irrigated areas in the Indus Basin; and (ii) the active promotion of tube well installation as a means to encourage agricultural development. Currently the challenges have changed with water logging and salinity persisting in part of the country and overuse the larger concern in other parts. Groundwater abstraction exceeds recharge in parts of Punjab and KP as well as in the non-canal command areas of Balochistan² (Table A3.2). Management and institutions by and large have not come to terms with the new scenario.

Table A3.2: Groundwater Balance under Normal Rainfall Conditions in Selected Provinces (BCM)

Recharge Components	Punjab	Sindh	Khyber Pakhtunkhwa	Balochistan
Rainfall recharge	8.10	2.42	1.28	1.49
Recharge from irrigation system	27.00	18.92	2.28	0.82
Return flow from ground water abstraction 15%–20%	8.50	0.97	0.16	0.1
Recharge from the river system	1.40	0.37	0.16	0.22
Total	45.00	22.68	3.88	2.63
Discharge Components				
Groundwater abstraction	42.50	4.30	2.18	0.56
Non-beneficial evapotranspiration losses	2.50	16.96	0.30	1.39
Base flow from rivers/sub surface		1.42	1.81	0.58
Total	45.00	22.68	4.29	2.53
Net Balance	0.00	0.00	-0.41	0.10

Source: Based on CWRAS (WB) Study "Groundwater Development and Management in Pakistan", 2004 and ADB Study "Exploitation of Fresh Groundwater in Pakistan" by ACE & Halcrow, 2003.

2. The figures for Balochistan largely reflect the oversupplies in the commands of the Kirthar and Pat Feeder canals.

Federal Level

As groundwater is a provincial topic and local management is the prime challenge, federal management is limited to general policies and support. The main organizations involved are the following:

- Ministry of Water Resources: mainly responsible for policy development
- Planning and Development Department: an oversight agency that reviews and approves projects though to date none have been proposed or approved
- Pakistan Council of Water Resources Research: research on water resources
- Environmental Protection Agency: control of industrial effluents.
- Water and Power Development Authority (WAPDA): established in 1958 to implement the Indus Basin Development Program including the drainage program and the Salinity Control and Reclamation Project (SCARP) deep tube wells that have been largely phased out where they are not functional and integrated with canal water management.

In the draft new national water policy there is a separate section on groundwater management. It emphasizes the need (i) for a regulatory framework including delineating areas for restricting abstraction; (ii) to prepare groundwater budgets for sub-basins and canal commands including promoting pumping in water logged areas; (iii) for better monitoring and the preparation of a groundwater atlas; and (iv) to optimize recharge using all options. It also pays special attention to areas with saline groundwater covered by fresh groundwater and recommends better technologies for skimming wells.

As with earlier policies, there is a risk that these recommendations will not be implemented. Still missing from the draft are the approaches to take to make groundwater management effective which would logically be the focus of a national water initiative. The approaches may differ in different areas but should ideally try to readjust surface water rights to synchronize with the scope for freshwater pumping, to develop joint management systems with water users associations (WUAs)/farmers' organizations, and to buy out farmers in highly stressed areas and phase out dysfunctional subsidies for pumping groundwater. This is a very important but very complex set of management challenges even in countries where compliance and the quality of institutions are much higher than they are in Pakistan.

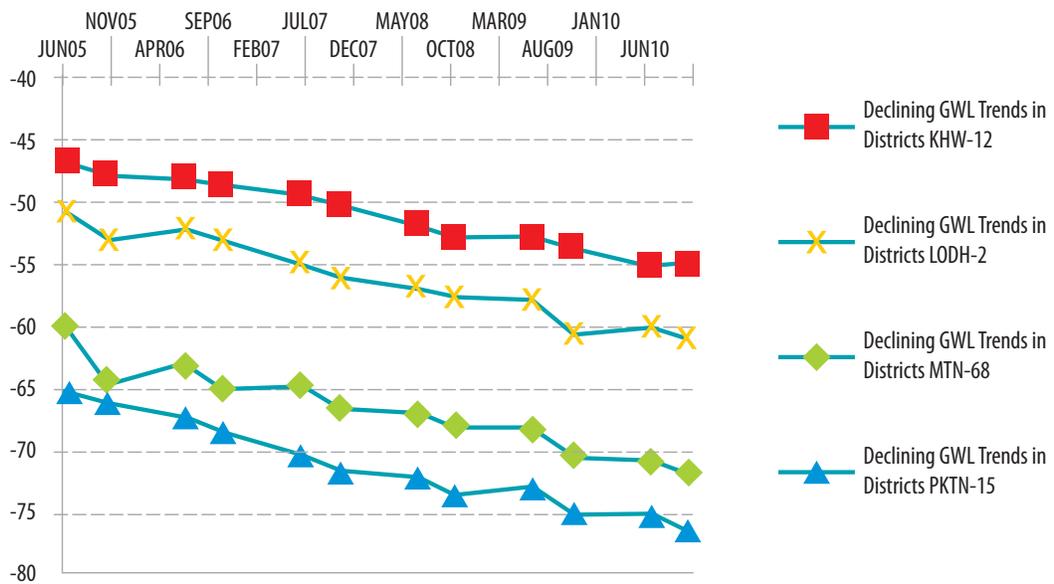
Punjab Province

Punjab has been the scene of a virtual groundwater revolution as the majority of Pakistan's million tube wells are located there. They use mainly low-cost centrifugal pumps driven by diesel engines. These so-called "peters" have made up for the unreliability and shortfall in surface water supplies from the canal system and have ensured that crop intensity exceeded 150%. They were also a major factor in the removal of water logging in the fresh and some of the saline groundwater zones in the province.

The intense groundwater pumping in the canal command areas in Punjab is, however, largely uncontrolled; there is a concern that more water is now pumped out than is recharged. Monitoring from 2003 to 2011 in all districts indicated that overall the system was in balance, but over the last 8 years, groundwater levels have dropped in 28 out of 38 districts. The most marked drops (more than 3 meters) were in Khanewal, Pakpattan, Kasur, and Multan (Figure A3.2). The 2010 floods reversed the trend somewhat, but overall the pattern is for the water table to rise in the head reaches of large canals and drop in the tail reaches of the irrigation system sometimes accompanied by deteriorating water quality. Another concern is areas with a relatively thin layer of fresh water perched on top of saline groundwater where over-pumping or poorly placed skimming wells can destroy the resource.

Figure A3.2: Water Table Decline in Tail Reach Areas (in feet) in Punjab from 2003 to 2011

Source: Ground water monitoring reports of the Directorate of Land Reclamation, Irrigation and Power Dept, Government of Punjab. Irrigation Department, Government of Punjab, on line at http://irrigation.punjab.gov.pk/Data/time_rate_changes_gw_vol_1.pdf



The other groundwater hotspot in Punjab is Lahore. Here the ground water is pumped very intensively from a small area, and recharge from the Ravi River has been reduced after upstream civil works. The operation of 450 tube wells by the water and sanitation authority (WASA) and of over 5000 small tube wells by housing colonies and industrial units has drastically reduced the groundwater level. This stress would have eased out if groundwater for the city had been sourced from a larger area and if the wells had been dug further away.

Thus there is reason for concern and attention even though groundwater development has brought substantial agricultural wealth in the last 30 years. Though the general picture is good, this is not the case in specific areas. In densely populated areas with intensive industrialization, the pollution of surface and groundwater due to unchecked discharge of industrial and sewerage effluents is problematic and has been associated with high local incidence of fluoride for instance.

Institutional involvement in groundwater management in Punjab is divided among a number of organizations none of which is actually in charge or capable of improving concurrent management or user management or of protecting the resource from pollution and contamination (Table A3.3).

Table A3.3: Agencies Involved with Groundwater in Punjab

Provincial Irrigation and Drainage Authority (PIDA)	PIDA is officially in charge of groundwater monitoring and management in the province; however, PIDAs are still transforming from newly established organizations to full-fledged implementing agencies.
WASA/ Municipal Committees	The authority is responsible for groundwater development/construction of tube wells within the areas of its jurisdiction which is reinforced under the proposed new municipal legislation.
Irrigation Departments	They are responsible for operations and maintenance of drainage tube wells in the saline groundwater zones. The Punjab Irrigation Department has established a network for monitoring groundwater levels and quality since, 2003 and regularly posts records on its website.
Farmers' Organizations	These organizations are responsible for operations and maintenance of distributaries but have no role in groundwater management as yet.
Provincial Agricultural Department	The department counts private tube wells and provided subsidies for them.
SCARP Monitoring Organization (SMO) (WAPDA)	The SMO makes bi-annual water level observations on selected control points mainly in the drainage (SCARP) project areas.

Source: Authors' compilation

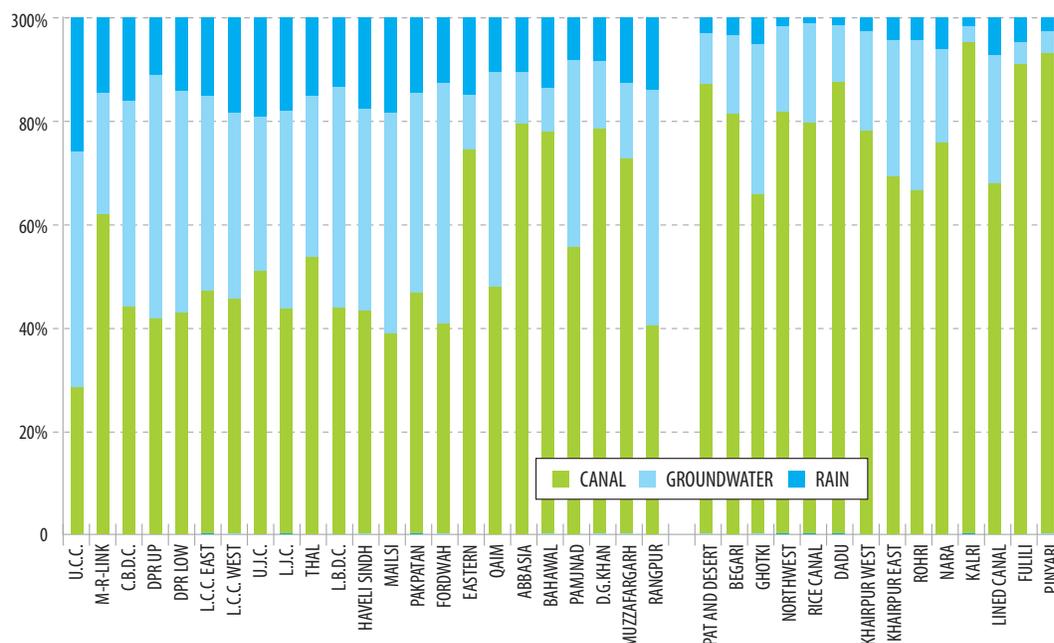


Figure A3.3: Proportion of Surface, Groundwater and Rain water used in Canal Commands
 Source: Habib, Zaigham (2008).
Policy and Strategic Lessons from the Evolution of Water Management in the Indus Basin Pakistan

Sindh Province

The groundwater situation in Sindh starkly contrasts with that in Punjab as is clear in Figure A3.3. Whereas in Punjab groundwater is largely used in the canal commands, in Sindh this is not the case (see right side of the graph).

For Sindh Province, 74% of the water available is lost to non-beneficial evaporation. This recharge, which predominantly results from canal losses and irrigation returns, occurs over both the fresh groundwater zones and saline groundwater zones of the province at a ratio of 25:75 by area. Water productivity in Sindh is also much less than in Punjab. For the different canal commands it ranges between 0.38–0.94 kilograms per cubic meter for wheat in Sindh while in Punjab the range is double that. In the Punjab in India it is 35% higher again than in the Punjab in Pakistan.

In Sindh, the canal water allowance needs to be adjusted as no farmer will pump groundwater when his land is almost water logged. The high irrigation duties boosted by additional supplies and the Puncho system of flood irrigation are anomalies in modern times. The lower left bank areas of the Indus (Badin and Thatta) are the premier problem spots in this respect and are water management disaster areas even by international standards. The high saline groundwater here is very much in the root zone, and water logging and salinity continue to persist due to the high irrigation supplies (often in the summer season [kharif] when there is less demand elsewhere) and the flat topography plus deteriorating natural drainage due to the tidal effect moving upstream after the scouring out of the Tidal Link. The impact concerns not only agricultural productivity but also basic drinking water supplies. The main source of drinking water is the highly polluted water in the three main irrigation canals. The situation in Badin and Thatta further deteriorated after the 2011 floods consolidated and further spread the high water tables.

Institutionally not much has happened in Sindh. There was no learning from the lower groundwater tables after the drought from 1999 to 2003. In 2000 and 2001, wheat production in the country was 20 million tons—the desired level of production—even with a 35% short-

age in surface water supplies. Similarly, crop yields in Sindh did not show any considerable decline during the drought mainly due to conservative techniques practiced by farmers. There was more stress on the groundwater, but it was not equivalent to the reduction in canal water. The pragmatic use of water by farmers during the recent drought has clearly shown that crop yields can be obtained with the timely use of lesser quantities of irrigation water as indicated in the recent studies on the crop yields in Punjab and Sindh. The invisibility of groundwater in Sindh is exacerbated by the fact that since 2008, monitoring water tables in the command area has been suspended in spite of persistent water logging.

Khyber Pakhtunkhwa Province

Due to the relative abundance of surface water resources, higher rainfall figures, and the fragmented nature of the landscape, the reliance on groundwater in KP has generally been lower than in Balochistan. Groundwater accounted for only an estimated 14% of agricultural water supplies in 2000 and is extracted from wells in alluvial and soft rocks. In the last 2 decades, however, private initiatives and development projects have led to a far more intensive exploitation of groundwater resources, particularly in the intermontane basins in the northern and central parts such as Swat, Buner, Dir, Peshawar, and Mardan. Estimates of the number of tube wells are outdated but were 14,000 in 2000, and if national trends are anything to go by, they currently will be in excess of 25,000. With the water table beyond the depth that can be accessed by centrifugal pumps in large parts of the province and surface water supplies more abundant, the “peter” engine revolution has not taken place in KP. Reliance has instead been more on relatively expensive turbines and submersible pumps.

Most tube wells (93%) are privately owned. Of the estimated public deep tube wells, approximately half are SCARP drainage-cum-irrigation wells whereas the remainder primarily provide irrigation services. The majority run on electricity as in Balochistan. Due to water logging in Mardan, WAPDA installed 491 SCARP tube wells in 1980s; however, with the gradual increase in groundwater abstraction, field conditions have more or less changed demanding attention as total pumping limits have been already attained (see Table A3.1). Areas at risk of overexploitation include Parachinar in the Federally Administered Tribal Area (FATA) close to Peshawar, the Shamozaï and Kotlai valleys in Swat and the Jandool and Adinzai valleys in Dir. Numerous tube wells have been constructed in these areas equipped with turbine pumps and often powered by tractors or former diesel truck engines. Many are funded by remittances from family members working in the Middle East. In these areas, landholdings are often small and fragmented. Selling water is quite common and often the only way to economically exploit the well. Lease and tenancy arrangements are common too in exchange for ensured irrigation supplies, particularly in areas where groundwater is the only source. In some intermontane valleys, in particular the main Swat Valley, tube wells are installed in the commands of the traditional irrigation systems both to be used concurrently and as a backup for the sometimes unreliable supplies in the traditional systems. In other parts of the province, groundwater development is less intense. In general, however, concurrent use of groundwater in canal commands in KP is less common than in Punjab.

Groundwater quality in KP is generally good to excellent. In the southern districts of Kohat, Karak, Bannu and D.I. Khan, the quality is mixed with patches of good, moderate, and poor groundwater with salinity as well as sodicity hazards. There are concerns, though, with respect to pollution from industries and agrochemicals. So far the provincial government has taken a passive attitude toward groundwater management. No monitoring of levels or quality is done

outside the few SCARP areas. A network of piezometers that was set up earlier has not been maintained.

Balochistan Province

Balochistan Province is in the arid zone with low rainfall and large evapotranspiration losses. With the introduction of deep-well pumping in the last 3–4 decades, groundwater resources have been rapidly depleted and levels have declined. In 10 of 19 sub-basins, groundwater is overused. At this stage, groundwater use exceeds recharge by 22%.³ Pishin Lora accounts for the largest imbalance and in several parts, the lucrative apple cultivation has been abandoned. Almost all use of groundwater is for agriculture; conservation measures for monitoring and management are required through awareness and the active participation of users who are largely farmers.

By and large there has been no institutional response to falling groundwater levels. Instead, rather the opposite has been true as a system of subsidized flat rates remains firmly in place— with farmers paying as little as US \$45/month for their consumption—that provides an incentive to continue pumping even for crops that economically make little sense such as winter wheat. The subsidized rate has been the subject of an intense policy debate between the Government of Balochistan and its main donors, in particular the Asian Development Bank. In the end no changes have been made except a ban on new electricity connections. The resistance both was from the farmers and from WAPDA with WAPDA staff often comfortable with flat rates as “line losses” no longer show up.

There has been little interest in groundwater recharge in Balochistan. The main intervention has been the development of recharge reservoirs, the so-called “delay actions dams” that have been constructed in Balochistan since the 1970s and now exceed 300 in number. Their aim is to intercept flood run-off and retain it for recharge. They typically have a storage capacity close to 1 million cubic meters, but there is wide variation. While the first generation of delay action dams in Balochistan was not successful, the new generation has fared much better because of better siting and because the impounded water was recharged through the downstream riverbed by means of water released from the storage reservoir. Where they were constructed, downstream water levels typically rose by 1.4 meters. Delay action dams are public investments and are relatively expensive. There is in fact a broader repertoire of recharge measures that could have been applied including catchment protection, infiltration trenches and sink pits, flood water spreading, cascade dams, and recharge from spate irrigation.

Participatory groundwater management has been recommended on several occasions as the “must do” strategy for Balochistan and is in fact at the heart of the Balochistan Groundwater Management Ordinance of 1978 which revolves around the local formulation and enforcement of groundwater usage rules. There are a few examples of areas where such rules developed spontaneously, but by and large this process needs to be facilitated. Globally there are several examples in similar autonomous settings where local groundwater management using a range of options including restricted use, more efficient irrigation systems, and local recharge have caused a turn-around even in areas where energy prices were subsidized.

3. Halcrow (2007). *Supporting public resource management in Balochistan. Basin-wide water resources availability and use (Final report)*

Urban Groundwater

Groundwater is becoming more important for many large and medium-sized cities in Pakistan. It has historically been the main source for Quetta, Lahore, and Peshawar but is increasingly important for Rawalpindi and Karachi. We highlight two high-profile urban groundwater users confronted with falling groundwater tables.

Lahore

The water supply has historically been based on groundwater. Due to increases in population and water demand, pumping has almost doubled in the last 20 years. The aquifer under Lahore is under great stress and has declined continuously by 0.67 meters per year with a cup-shaped depression in the groundwater flow system inducing flow from surrounding areas. The existing network of 460 WASA wells and more than 4000 wells belonging to private agencies and industrial units act more like “dewatering wells” due to intensive pumping in the urban area.

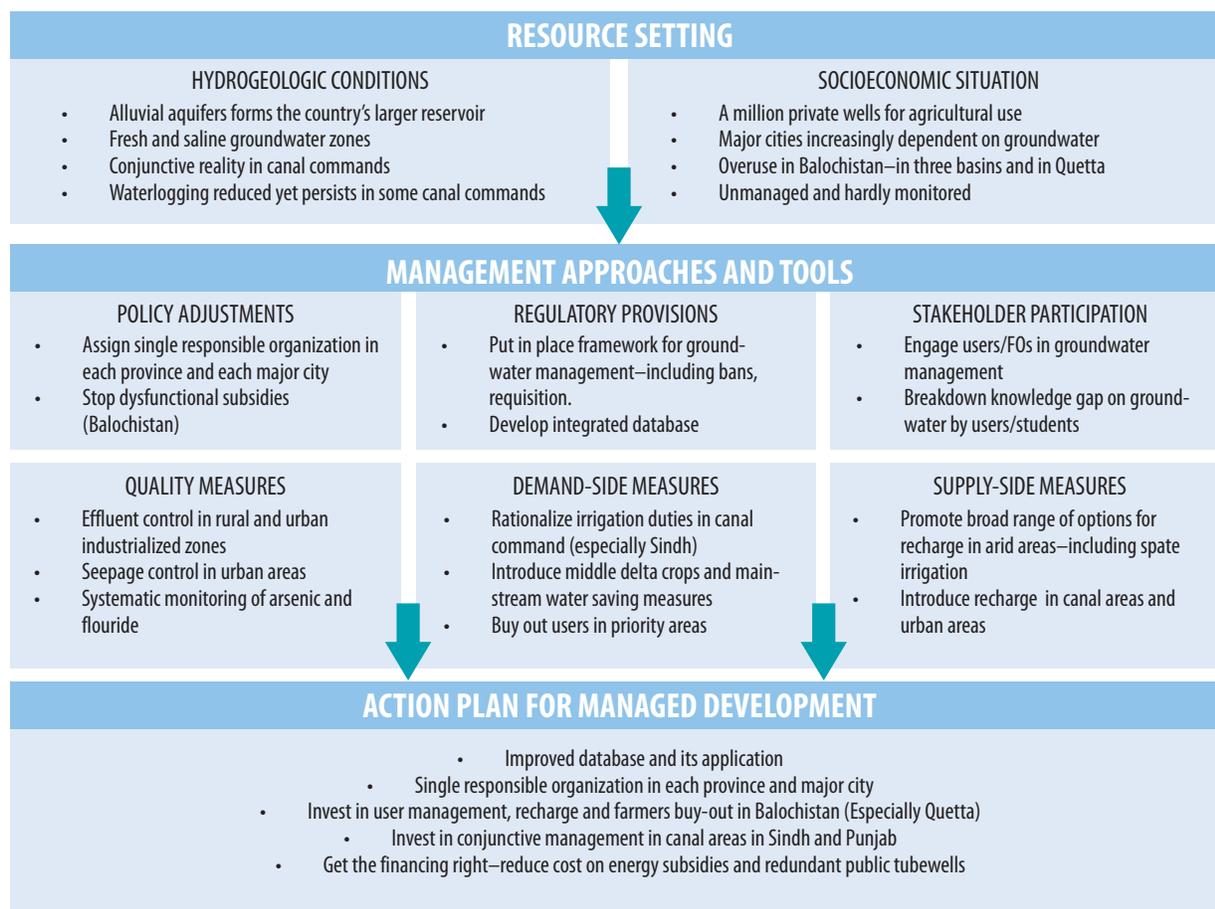
The aquifer is also under great threat due to the unchecked discharge of sewerage and industrial effluents from more than 1000 industrial units and due to the intrusion of saline groundwater from the southwest. In addition to other options, an immediate action that could provide some relief is to expand the well field toward the Ravi River and the Bambanwala-Ravi-Bedian-Diplpur Canal and to control large system losses.

Quetta

Quetta has the unenviable reputation of being a groundwater disaster in the making. In the 1990s it was predicted that by 2016 water from Quetta’s alluvial aquifer would run out. This prediction has been accurate; only drilling in the limestone and sand stone aquifers around Quetta Valley in the last 10 years have averted disaster. The very worrying development is that this hard rock groundwater extraction is not only for the urban water supply as drilling for agricultural tube wells has also been driven to this extreme.

Pumping from 535 tube wells in the public sector, 1322 private wells for irrigation in the Quetta Valley, and 137 private wells mainly for private water supply is placing a fatal stress on the groundwater aquifer. Existing pumping through WASA, the Public Health and Engineering Department and Military and Engineering Services tube wells is about 50 million cubic meters per year. The total recharge for the Quetta Sub-Basin is estimated at 88 million cubic meters per year, but the abstraction is 101 million including 24 million from the hard rock aquifer that until 10 years ago was non-existent. Water tables have shown a continuous decline of around 2 meters per year. At present some of the wells show a depth to the water level of about 130 meters.

To relieve some pressure on the alluvial aquifer, the Government of Balochistan is planning to build two dams each about 70 kilometers from Quetta City to supply drinking water. The cost of this is substantial, in particular as concrete structures are proposed, with the price of the main dam costing US \$100 million. The reservoirs will supply 30% of the water demand of the city; complementary measures are thus required including buying up agricultural wells in Quetta Valley (the cost of which would be comparable to interest on the dam investment), introducing a broad range of recharge and efficiency measures (also in reducing non-revenue water) and an all-out ban on new and redeveloped tube wells.



Priority Actions in the Short Term

Based on the above, a framework for managed groundwater development is summarized, using the Groundwater Management Advisory Team (GW MATE) framework (Figure A3.4).

Details of the five short-term priority actions are the following.

1. Develop and share a sound groundwater database, develop applications with users (farmers, farmers' organization, urban managers), and incorporate it in short courses and university curricula. At present, data are patchy and reporting is not always regular. There are several data collection efforts, but they are spread over various organizations and are not connected. There are major gaps in KP, Sindh, and the non-canal commands in general and in the overall link of groundwater quality and quantity with water management.
2. Assign a single organization responsible for groundwater management in each province and also in each major city. Institutional changes are required. Practically speaking, groundwater has no owner either federal or provincial. There have been some minor improvements in the last few years such as the groundwater cell in the Irrigation and Power Department in Punjab and the ban on new tube well connections in Balochistan. All in all, however, it does not add up to much. The primary responsibility for groundwater management should be placed with a strong organization like the irrigation and power department or the planning department or in WASAs in urban areas in. The focus should be on management and coordination.

Figure A3.4: Framework for Groundwater Management in Pakistan
Source: Authors' calculations

3. Invest in projects in user management, recharge, and reducing demand for groundwater in Balochistan. This can follow similar successful programs elsewhere (e.g., Andhra Pradesh, India) and systematically introduce a large range of recharge measures (soak pits, subsurface dams, spate irrigation, catchment protection) beyond costly delay action dams as well as demand reduction measures (special varieties, micro-irrigation, mulching). The particular hotspot is Quetta where farmers' tube wells should be bought out. The cost would be the same as the interest on loans for the two new proposed drinking water reservoirs.
4. Invest in a project on concurrent water management in the canal areas. In Sindh this should consist of rationalizing canal water supplies and investing in drainage and reuse. In Punjab it should consist of developing on-farm water activities that reduce non-beneficial evaporation, of promoting groundwater recharge within the canal systems (by routing peak flows for instance), and of adjusting water duties within canals in the first place.

5. Change the financing. A considerable amount of scarce public money is still wasted in groundwater due to two major leaks. The first is the continued operation of SCARP (drainage) tube wells in Sindh and KP, many of which are non-functional and are no longer required except in some of the saline areas. In fact, SCARP tube wells have long been phased out in Punjab, yet in Sindh and KP they are kept on the books and incur a large unnecessary and unwarranted electricity bill. The second leak is the persistence of electricity subsidies in Balochistan at a flat rate of PRs4000/month per “legal” tube well. This entices farmers to pump for crops that have no economic justification—like winter wheat—and in general constitutes a subsidy for the prosperous. The situation is such that with the agreement of WAPDA, farmers whose tube wells have collapsed because of overdraft now “trade” their connections to farmers elsewhere along with their equipment thus evading the ban on new tube well connections and perpetuating overuse.

Situation Analysis

Background

The last two decades bear witness to Pakistan's vulnerability to floods. Pakistan is exposed to extreme weather conditions causing floods and droughts, a long-standing reality that is likely to be exacerbated by climate change. The exceptional intensity and prolonged periods of rain in 2010 and 2011 and the floods that resulted clearly highlighted the existing physical and institutional limitations and policy environment for dealing with floods, including inadequate reservoir operations, shortfalls of irrigation and drainage operations, insufficient maintenance of flood protection works, and the encroachment on natural drains.

Capacity deficits exist both in provinces and districts, and there is a lack of effective coordination among responding institutions caused in part by limited technical capacity for disseminating early warnings, for disaster preparedness, for responding to emergencies, and for constructing disaster mitigation civil works and infrastructure related to reservoir capacity which covers only 9% of water needs (less than 30 days of average flow). Local communities do not have disaster preparedness information, and there is a general lack of awareness and education among people regularly affected by floods, especially populations living on active floodplains or in the low lying areas of canal commands.

While the devastating consequences of floods are undeniable, the possible positive effect of heavy rainfall must be recognized including irrigation of dry lands, the recharge of groundwater in areas where it has been overused, and the impact on the environment and livelihoods in the Indus Delta. Where possible, a response plan should not only reduce or prevent the negative impacts of the floods but should also make use of the beneficial impacts of the high rainfall events.

Missing Links in the Pre- and Post-Flood Scenario

Lack of Pre-Flood Management

In many provinces of Pakistan, there is currently no pre-flood planning or management. Preventive measures such as proactive community-based work on the safety of embankments of canals and protective bunds have not been undertaken, and the safe discharge capacities of existing crossing structures (e.g., bridges and headworks) are quite limited. The 1992 flooding in Punjab and the 2005 and 2011 Sindh Indus Left Bank floods exposed the problems of inadequate drainage and also the delayed closing of canal supplies and the haphazard breaching/cutting of canals and drains in areas in danger of floods. The examples of local people who stayed and worked on the protective embankments for their villages and towns and saved many from inundation show that a good pre-flood strategy will certainly produce enduring results.

Absence of a Post-Flood Scenario

The post-flood scenario in Pakistan is also alarming as rehabilitation is a huge challenge. Restoring roads, bridges, and water works is particularly difficult throughout the country. Principal crops (rice, cotton, and sorghum) are destroyed, and water and sanitation facilities are not available in many affected areas. Stagnant water has led to many water borne diseases.

Climate Change and Rainfall Patterns

Research by the Pakistan Meteorological Department (PMD) based on long-term climate data revealed that the monsoonal zone of Pakistan (a region that receives almost 65% of total monsoon rains) has shifted 80–100 kilometers (km) from the northeast (upper Punjab and Kashmir) to the northwest (Khyber Pakhtunkhwa (KP) and northwest Punjab). The study suggests more heavy rainfall events during future monsoon seasons over northwest Pakistan as a likely scenario. As a result, areas along the western rivers of the country (Indus and Kabul) will be extremely vulnerable to floods similar to the one in 2010. In 2011, one month of rainfall unprecedented in 150 years in Sindh caused over 50 canal breaches. Also the extraordinary floods in Makran in 1999 and 2007 suggest that even in Balochistan exposure is increasing.

Glacial Lake Outburst Floods

Due to accelerated global warming, the glaciers of the Himalayan Karakorum Hindu Kush (HKH) region in Pakistan are retreating causing rapid accumulations of water in mountain lakes.¹ As glaciers retreat, glacial lakes form behind moraines or ice dams or inside the glaciers which can breach suddenly, leading to the discharge of huge volumes of water and debris. Such outbursts have the potential to release millions of cubic meters of water in a few hours causing catastrophic flooding downstream with serious damage to life, property, forests, farms, and infrastructure. Known as glacial lake outburst floods (GLOFs), a single devastating event can result in major economic damage and social repercussions for the sizeable population living in the HKH belt in Pakistan. Current (baseline) disaster management policies and risk reduction and preparedness plans in Pakistan address recurrent natural hazards in the country but are not yet geared to deal with the new dimension of GLOF threats. According to a study conducted by International Centre for Integrated Mountain Development (ICIMOD), 5218 glaciers with coverage of around 15,040 square km and 2,420 lakes were identified and mapped in Pakistan. Among the lakes, 52 were classified as having a potential GLOF threat. These glaciers and glacial lakes are the major source of water for agricultural, industrial, and hydropower development in the mountainous regions. Records in the Himalayas show that once every 3–10 years, a GLOF has occurred with varying degrees of socioeconomic impact, and 35 destructive outburst floods have been recorded in the Karakoram region in the past 200 years, but the fre-

1. ICIMOD. October 2011. *Background Paper for the Friends of Democratic Pakistan Water Sector Task Force.*

quency of GLOFs in Pakistan has increased recently to about 1–2 per year. An understanding of the mountainous headwaters of the Indus and especially of the snow and ice conditions is lacking and/or inadequate. This is also a major gap in the knowledge essential for hydrological forecasting in the behavior of the Indus River system.

Narrow Legal Basis

The existing national flood protection Plan is too narrow because it focuses only on measures before a flood, though there is a national policy that provides for relief and rescue.² A number of disaster management tasks have been handed over to authorities to establish guidelines and manuals without clear legal jurisdiction.

Lack of Effective Disaster Risk Management

Most flood response measures are precautionary. In this context, a very important step is to define the roles of emergency authorities. As emergency relief plans rely in principle on the provincial authorities, it is their task to assign local authorities to certain tasks and to establish disaster risk management plans. The National Disaster Management Authority (NDMA) has published guidelines and a proposed outline that might help local authorities, but currently NDMA has an advisory role and is not involved in approving local plans though such a role might be a good thing when it comes to flood management.³ In addition, none of Pakistan's cities has effective storm water management arrangements to deal with exceptional rainfall events; an urban flood is a disaster waiting to happen.

Changing Paradigms and Institutions

As a consequence of the severe floods in 1976, the Federal Flood Commission (FFC) was established in 1977 to integrate flood management planning with national policy. The objective was to shift from a crisis-provoked approach to a risk-management approach and to ensure the integrated coordination and management of floods and flood protection works. The FFC is also responsible for formulating a national flood protection plan that includes structural and non-structural elements and for implementing it in the provinces. The Water and Power Development Authority (WAPDA) and PMD also have important roles to play including data collection, forecasting, and disseminating early warnings.

The National Disaster Risk Management Framework was launched in March 2007 to provide strategic guidance for disaster relief in the country and to highlight priorities for 5 years. It identifies nine priorities: institutional and legal arrangements, a hazard and vulnerability assessment, training, education and awareness, planning, reducing community and local risks, a multi-hazard early warning system, mainstreaming disaster relief into development, an emergency response system, and capacity development for post-disaster recovery. It also recommends structures for disaster relief for federal, provincial, district, tehsil, union council, and community-based organizations. It further identifies roles and responsibilities of various stakeholders including ministries, departments, technical agencies, donors, nongovernment organizations (NGOs) and the UN Agencies.

The establishment of provincial disaster management authorities (PDMA) followed in 2008 and 2009. In Punjab, Sindh, and Balochistan the authorities were under existing provincial revenue departments. In KP, the PDMA was established as an independent authority directly

2. WCDR. 2005. *Review of Disaster Management Policies and Systems in Pakistan*.

3. Some of the provincial disaster risk management plans as well as the guidelines are published at www.ndma.gov.pk.

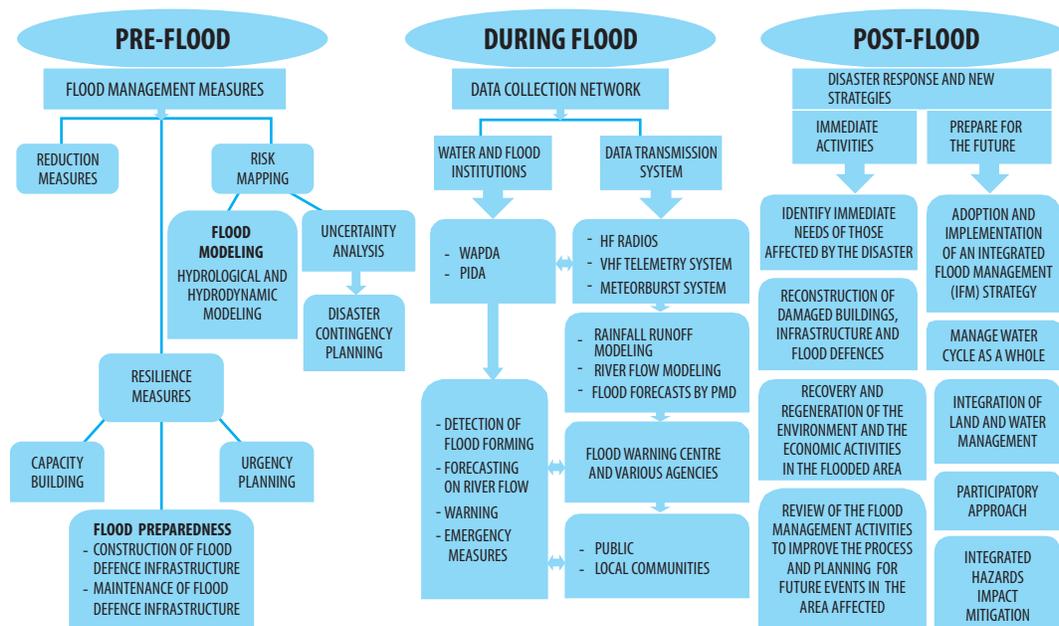


Figure A4.1: FLOOD MANAGEMENT—Primary Solutions Pre-, During, and Post-Floods

reporting to the chief secretary whereas the Gilgit-Baltistan authority was established under the home department. In addition, NDMA has started a disaster relief mainstreaming initiative targeting the Planning Commission; the Ministry of Water and Power; the Ministry of Housing and Works; the Ministry of Industries, Production and Special Initiatives; and the National Engineering Service of Pakistan (NESPAK). This has resulted in plans and has included disaster relief in the development planning tools of the federal government.

These activities are commendable; the main challenges are enforcement and the overall flood-proofing of the country not only with special flood protection measures but also by improving the overall hydraulic structures including better drainage, flood water retention (including spate irrigation), and spreading.

Primary Solutions

Flood management can be divided into pre-, during and post-flood phases as shown in Figure A4.1.

Pre-Flood Activities

Watershed Forest Management

Pakistan's deforestation rate was estimated by the World Wildlife Federation in 2009 at 2.1% per year, the highest in Asia. Between 1992 and 2001, the country's forest land decreased from over 4.24 million hectares to 3.44 million hectares. Deforestation is greatest in the Indus Delta mangroves at an annual rate of 2.3% compared with 1.99% for coniferous forests and 0.23% for riverine forests. Currently, there is no clear national policy to combat deforestation much of which is driven by governmental initiatives. In past decades in the Indus Delta, less than 50% of the mangrove forest area has been inundated even in high floods. As a result, the mangrove forest is shrinking alarmingly, and less salt-tolerant species have almost disappeared.⁴

4. Asian Development Bank, World Bank and Government of Pakistan. 2010. *Pakistan Floods 2010: Preliminary Damage and Needs Assessment*. p. 62.

Deforestation can be directly linked with the flood of 2010 and can be seen as one of the reasons for its devastating effects. Deforestation exposes the soil which aggravates erosion as soil with sparse or no vegetation is far more exposed to external weather influences and therefore to the danger of being washed away compared with soil in forest. Furthermore, a lack of vegetation combined with steep terrain enhances the risk of landslides. Eroded soil gets into the river network and increases siltation and reduces water storage capacity. In the long run, washed-out areas will also suffer from significant loss of agricultural productivity. Woodlands, on the other hand, are capable of absorbing more water as recharge which is an important part of sustainable groundwater resources, so planting trees in suitable targeted areas can be a very effective measure for preventing or mitigating the negative consequences of floods, and it can be much cheaper than achieving the same goals in an artificial way (e.g., constructing check dams). Given recent events, the following measures should be taken:

- Develop a strategic action plan for rehabilitating the lost forest cover in suitable areas including actions to stop further cutting for commercial purposes and potentially compensating for cut timber lost in the flood. This should be done on a commercial basis catering for in-country demand for timber and non-timber products as has been achieved spectacularly in the People's Republic of China.
- Develop a program for promoting community-based forest restoration including energy plantations, linear plantations on farms and agriculture fields, and linear plantations on water channels and rural roadsides. Promoting community nurseries will help provide stocks of seedlings for the purpose.

Community-Based Disaster Risk Management

Considering the recent recurrent disasters in Pakistan, it is evident that individual, community, and public sector responses and resilience need to be enhanced. Community outreach by union councils should raise awareness and disseminate basic knowledge and understanding of local vulnerabilities and capacities in addition to preparing disaster management maps, forming disaster management committees, and enhancing preparedness and the capacity to respond to emergencies. To conduct these activities including installing equipment costs Pakistan rupees (PRs) 500,000–1,000,000, so for 1000 communities, the cost will be approximately PRs 500,000,000. The focus should be on the most exposed areas, i.e., the flood plains and the low lying areas in the canal commands as well as areas prone to drainage congestion.

Maintain Existing Flood Protection Infrastructure

Embankments: Along the rivers of Pakistan there are more than 6000 km of embankments to protect the population from floods; nevertheless, the events of 2010 tragically showed that in some locations the flood-carrying capacity or condition of these embankments was not sufficient (footnote 4, page 79). The breaches were sometimes more than 100 meters long and sometimes extremely close together due to the limited capacity of the hydraulic infrastructure. This leads to the conclusion that some embankments might have been in bad condition before the flood and that there is a need to improve the safe discharge capacity of bridges and head works. The following actions need to be considered.

- Repair existing damaged embankments and assess all the embankments with regard to durability and possible invisible damage.
- Evaluate the inundation from the 2010 floods and compile lessons learned for further planning and decisions.
- Construct new embankments to complete the network to achieve maximum security for the people.
- Work on a national inventory database of embankments and breaching section of bar-

rages, document their current condition, and take into consideration information in danger and hazard maps.

- Consider installing modern electronic embankment vigilance methods.
- Provide resources for maintaining the infrastructure to keep it in good shape for future events.

These actions can be divided into long-term and short-term measures. In the first place it is of great importance to repair the embankments before the annual monsoon season begins in July. Afterwards, the network should be improved and maintained. This is a provincial matter, so they must reserve adequate operation and maintenance funds.

Essential public infrastructure: Public infrastructure suffered a great deal of damage in the 2010 flood. Hospitals, police stations, and schools were insufficiently protected which aggravated the situation for the already suffering population. If these facilities don't work properly, it is difficult for public authorities to fulfill their assigned tasks and duties, and all emergency plans therefore become useless. The lesson learned in 2010 should be considered in the future planning of such facilities. For already existing facilities, there should be emergency response plans to keep the infrastructure fully functioning during floods.

Integrated Flood Management

This strategy enlarges the focus of flood management and brings more stakeholders and issues to the table. It includes switching from simple flood control to an integrated flood management (IFM) approach. Integrated, multi-disciplinary actions are needed to rethink traditional flood management to effectively using flood water for livelihoods and groundwater recharge in addition to safely disposing of extra floodwater. The approach should be from top to bottom to manage small flows of water rather than just handling large flows. For river basin management, areas like Chasma-Tunsa, Kabul-Swat, and Jehlum-Chanab should be given priority as well as areas where there is still considerable scope for flood water spreading and expanding spate irrigation. A start could be made on a smaller river as a model basin and then scaled up. The following should be part of IFM.

Legal framework. Laws relating to IFM must clearly establish a framework that defines the rights and obligations of institutions and individuals at both the planning and operational phases of all stages of a flood, i.e., before, during, and after. At the same time, it also needs to provide an equitable framework for different sectors of society, including present and future generations, to duly respect the principles of IFM and take account of the need to maintain the life-support provided by natural resources. This framework may address resource sharing, financial support, and other practical measures.⁵

Currently in Pakistan, there are no effective national flood management laws, so the authorities in charge just focus on parts of the whole concept.⁶ IFM should be considered in a variety of national laws including those on water, rivers, disaster management, land use, regional and municipal building and safety codes, natural resource management and environmental protection, and freedom of information.

Floodplain mapping, zoning, and enforcement: Efforts have improved in the past year (origi-

5. *Associated Programme on Flood Management*. <http://www.apfm.info>

6. *Information about federal statutes can be found at: <http://www.ljcp.gov.pk/Menu%20Items/Statutes/Federal/statutes-%20federal-%20control%20page.htm>*

nally this was to be part of the Second Flood Protection Sector Project 2000–2007 but was withdrawn for social and political reasons) with various projects and will be further improved, but it would be desirable to update the maps more regularly after each alternation in an area.⁷ It is also important to import the lessons learned in 2010. Pakistan is currently developing a geographic information system-based flood hazard map downstream of Panjnad.

Updated maps then have to be used in actual precautionary scenarios. They should be used to plan settlement strategies and urban development. It is necessary to stop encroaching on floodplains and to regulate land use in flood prone areas. For that reason, the government is allocating land to farmers in areas other than riverbeds to discourage encroachment. In Lai Nul-lah, strict laws and penalties have been introduced for encroaching and for dumping garbage. More than 2000 structures have been removed by paying market prices. At the same time, a comprehensive resettlement plan has been prepared to avoid any civic or social problems.

The flood of 2010 can also be seen as chance to restore areas that should never have been used for cultivation or for human settlements in the first place. The federal government should therefore offer people living in flood prone areas favorable opportunities for resettlement in safer areas by buying back their land. For people who lost everything in 2010, such programs might at the moment be very welcome (footnote 6). In any case, relief organizations and local authorities should withstand the temptation to just rebuild destroyed houses without considering new data and flood model maps after the floods 2010 and 2011.

Storm water removal and adequate drainage: Natural drains have been blocked and silted by encroachment and the construction of roads and railways and canals. This has undermined their ability to deal with high discharges.

Flood water spreading and retention: This can be done outside the reservoirs by better flood water spreading and investment in viable spate irrigation and by recharge from canals.

Federal forest laws: Deforestation was one of the main reasons for the devastating events in 2010; it is absolutely necessary to protect national forests. This task was previously managed by the Pakistan Environment Ministry (devolved under the 18th amendment to the Constitution) which in turn allocated it to the National Council for Conservation of Wildlife and the Pakistan Forest Institute; nevertheless, enforcing laws is a problem. Forest protection is weak, and penalties devised by various legal instruments such as the Pakistan Forest Act (1927), the Hazara Forest Act (1936), provincial wildlife ordinances, and related acts are ineffective. So far the federal government has been unable to cope with forest encroachment, theft, and illegal logging. These infractions are trans-boundary in nature and are not covered effectively by existing laws.⁸ Therefore it is necessary to develop a more efficient legal framework to penalize and punish violations and to establish the human resources to enforce it.

Environmental aspects: IFM also involves environmental protection such as wetland preservation and reforestation that improves flood management as a side benefit. On the other hand, IFM must take environmental concerns into account when new projects are planned.⁹

7. DAWN. <http://archives.dawn.com/archives/30332>

8. *National Forest Policy Review Pakistan*. (<http://ftp.fao.org/docrep/fao/005/AC921E/AC921E08.pdf>).

9. *Environmental Aspects of Integrated Flood Management Paper* (www.apfm.info).

Economic aspects: Normally flood management includes risk calculations comparing the economic cost of flood defense strategies with their full benefits. In Pakistan, the risk of floods is in general very high, and floods are recurring events, so it is estimated that embankments are an investment that pays off in the longer term if the facility is maintained and well designed.

National Flood Protection Plan (IV)

The FFC is responsible for formulating a national flood protection plan and implementing it in the provinces. To make this a federal task was decided after the floods of 1973 and 1976 which showed that the flood protection schemes in the provinces were insufficient. There have been four plans the last of which (2008–2018) is still awaiting approval with FFC revisions after the 2010 floods. The content of these plans is usually more or less the same; what changes is the budget. Money is mainly spent to install flood protection schemes in economically important areas (1200 schemes to date), along with purchasing infrastructure such as weather radar, early warning systems, and flood modeling.¹⁰ These projects were co-funded by the Asian Development Bank (ADB) and the Government of Pakistan. The three prior plans combined cost PRs1.4 billion (\$164 million). The current plan had a previously estimated budget of PRs30 billion that is now PRs50 billion.

Currently flood protection works are undertaken through the normal public sector develop program.¹¹ with a budget for 2010–2011 of PRs 735.798 million to spend in Azad Kashmir(AJK), Balochistan, the Federally Administered Tribal Areas (FATA), Gilgit-Baltistan, Punjab, and Sindh. Only PRs276.76 million was released to the provinces/federal line agencies, however, which has seriously hampered progress. Most of the schemes remain incomplete due to a shortage of funds.

Maintain, Improve, and Expand Infrastructure

Dams: Along the main Indus River, only the Tarbela Reservoir today plays an active role in physical flood control. The ideal use of the reservoir will be to take away flood peaks when most of the damage to infrastructure is done. This was well illustrated in the analysis of the 2010 flood. At the maximum peak, 23,400 cubic meters (m³/second (s)) flowed into the Tarbela Reservoir compared to a maximum outflow of 16,900 m³/s. The reservoir thus was able to reduce the flood peak by up to 6500 m³/s. This saved the downstream river areas from even worse damage than they experienced. Adequate reservoir operations are essential, especially avoiding emergency releases as the man-made flood episode from the Mangla Dam in 1992 showed.

Several projects are ongoing at the moment to enhance water storage capacity though some had to deal with major setbacks after the flood of 2010. There are currently 20 dam projects in the pipeline or ongoing for a total additional water storage of 28 cubic km, and there are several small projects in progress offering an additional 3 cubic km of water storage. In comparison with other countries, Pakistan does have a very small storage capacity at 30 days of river runoff (around 13% of the annual flow of the rivers) of the Indus whereas India can store between 120 and 220 days of runoff from its main rivers.¹² Increasing water storage capacity is therefore indispensable for better flood and drought management.

10. ADB. <http://www.adb.org/Documents/Reports/Validation/PAK/in215-08.pdf>

11. Government of Pakistan, Planning Commission. <http://www.planningcommission.gov.pk/psdp2010-11.html>

12. World Bank. 2005. *Pakistan - Country Water Resources Assistance Strategy: Water Economy Running Dry*. p. 60.

Large dams are important for flood prevention while small dams usually have less influence because they don't have much additional storage capacity. Their primary goal is to support the irrigation network or the energy sector, and their only advantage in floods is that they hold back sediments. This leads to the conclusion that smaller dams are of more importance in drought management.

WAPDA has stated that flood control is an important issue for all new reservoirs planned for the coming years (Figure 5 in the WSTF Main Report). The Munda Dam is of special interest for flood control in the lower Swat River. The storage will be 1600 million cubic meters of which 300 million will be allocated for flood prevention. The annual inflow to the Munda Dam is about 7000 million cubic meters; hence the dam can hold back 4% of the annual flow volume.

For new reservoirs to be efficient tools for flood mitigation, proper operations have to be implemented including maximum and minimum water stages in the reservoir during flood seasons, procedures for pre-flood release, and clearly stated responsibilities. In order to form a hydrological base for proper flood forecasting, a measurement program on snow storage, relevant meteorological parameters, and discharge measurements higher up in the river basin has to be established.

Ongoing Projects

Currently, there are several projects ongoing that will add significant storage capacity (more than 1 cubic km) for sustainable flood management. All of them are on the western rivers of the Indus Basin.¹³

Gomal Zam Dam (estimated to be finished in December 2012). With its estimated storage capacity of 1.1 cubic km (0.9 million acre feet [MAF]), this is the largest and therefore the most important project for flood prevention currently under construction. It has the following main objectives.

- The project will provide 316,232 acre feet of water annually to irrigate about 77,353 hectares (191,139 acres) year round including perennial water rights covering 33,353 hectares (82,415 acres) and a cultivatable command area and flood water rights area comprising 44,000 hectares (108,724 acres). The project will supply water to all these lands. Cropping intensity would be 120% for the perennial and 100% and 60% for flood water right areas respectively.
- The project will provide cheaper power than thermal power. A small power plant will be installed at the toe of the dam with installed capacity of 17.4 megawatts (MW).
- The scheme will control the flash floods that damage fields, roads, bridges, canals, and buildings and cost an estimated PRs183 million to repair annually.
- Employment opportunities for processing farm production, a reliable water supply for farmers, water for domestic use, and a road system are all potential indirect benefits from the dam.

Additional Options

Building new dams is not the only way to enhance water storage capacity. The following possibilities would also improve the situation.

13. For a complete list of all the ongoing and planned projects visit: <http://www.wapda.gov.pk/htmls/ongoing-index.html>.

Enlarge the capacity of existing dams: Technical and engineering improvements and developments mean that in some cases it would be possible to enhance existing storage capacity (another option would be desiltation). This was done on the Mangla Dam (Mangla Dam Raising Project) between 2004 and 2007 and created 3.5 cubic km of additional water storage.¹⁴ On the downside, the additional capacity is very limited and is not enough to make other new projects such as large dams obsolete.

Detention and retention basins: Detention and retention basins are natural depressions or excavations that can be used for temporarily storing flood water to reduce peak floods downstream. Detention basins are similar to retention basins except for the fact that the latter do not have controlled outlets. Detention basins hold the water temporarily and then slowly release it through a natural or man-made drainage channel, while water collected in retention basins slowly percolates into the ground or evaporates. According to the topography, the type and size of detention and retention basins can be different. Often, natural depressions are also used for agricultural purposes.¹⁵

Pakistan has large arid or semi-arid areas that are sparsely populated and do not have much infrastructure that could be used as retention and recharge basins when there are no other possibilities for storing the water from a devastating flood. Following the 2011 rainfall and the failure of the local drainage system, diverting storm water to the Thar Desert through natural old river courses (dhoras) was suggested. These dhoras are either blocked by the existing drainage system or by roads and encroachments. A natural gradient will facilitate the flow under gravity to the depressions in the area. This cannot, however, replace the need for new large dams to increase storage to feed the irrigation system

Plans for flooding deserts in Pakistan are not yet advanced, but in theory they seem feasible. Nevertheless, there are several environmental concerns to consider. First, deserts are very vulnerable ecosystems that could radically change with flooding. Over the longer term, it would also bring new sediment to the area that could change biodiversity dramatically and could make the situation worse considering that flood water often carries hazardous materials. To evaluate all the possibilities of such a measure is a difficult undertaking; the full ramifications are barely predictable. It might be an interim solution until Pakistan enhances storage capacity to a sufficient level.

Improve drainage: Water logging persists in Sindh covering 2 million hectares even in a normal year. The floods of 2010 and 2011 may expand this area as did the floods of the 1960s. Water logging is linked to high-surface water deliveries—often above the high duties—and the limited use of groundwater even in areas where groundwater quality is acceptable. Where water logging persists, excess water cannot be absorbed, and floods have an extended impact. Investment in drainage in the past—the Salinity Control and Reclamation Project (SCARP) and the left bank outfall drain—has focused on removing effluent, not on retaining and evacuating storm water. Storm water removal in Sindh has become even less effective than elsewhere in the country because natural drainage paths have been encroached, silted up, or blocked.

Revisiting the balance between surface water supplies and the potential to expand groundwater irrigation and surface water irrigation in the vulnerable lowlands of Sindh is vital. Based on this

14. Government of Pakistan, Water and Power Development Authority. www.wapda.gov.pk

15. *Environmental Aspects of Integrated Flood Management*. p. 43. www.apfm.info

and following the work on the Left Bank Drainage Master Plan that is ongoing, specific investments in drainage should be planned including the re-operationalization of unused facilities. The master plan also devotes ample attention to tidal effects and their mitigation with mangrove rehabilitation, flap gates on canal outfalls, and even bio-saline agriculture. An integrated overhaul of water management is required in Sindh and in other hotspots and highly exposed areas. In a related project of the World Bank in collaboration with the Government of Pakistan and the Government of Sindh, there is an action plan to address flood vulnerability and socioeconomic and livelihood issues of people living close to the left bank outfall drain and in the coastal zone of southern Sindh in the districts of Badin and Thatta.¹⁶

Invest in benefits of floods: Floods are not only a hazard, they also bring benefits; in fact, medium-sized floods and short duration water are the major source of agricultural livelihoods in the districts of DI Khan, Tank, Kohat, Laki Marwat, Bannu (KP), DG Khan, Rajanpur, Mianwali (Punjab), Kacchi, Sibi, Jal Magsi, Qila Saifullah, Lorelai, Musakhel, Barkhan, Las Bela (Balochistan), Dadu, Larkana, Jamshoro, Karachi and Thatta (Sindh). In these areas, spate irrigation systems need to be harnessed and their productivity improved as they help to retain run-off and avoid floods.

Revisit irrigation, drainage, and flood management: The floods of 2005, 2010, and 2011 affected large parts of the canal command areas in the Indus Basin. Local damage was in many cases exacerbated by late closure of irrigation supplies and haphazard cuts in drains and canals. The operational procedures for flood management within the canal commands need to be revised and widely shared. On a larger scale, the capacity of the shallow aquifer to absorb part of the excess water needs to be better understood and developed combining recharge with flood management by keeping ample space in the upper layers of the canal system.

Preserve Wetlands

Pakistan supports an estimated 780,000 hectares of wetlands that cover 9.7% of the total surface area of the country, and more than 225 significant wetlands sites are on record. Pakistan's wetlands have an important role in flood management as they are not only environments for many species, they can also serve the public as flood mitigation zones and buffers. The dhands in Sindh are examples of wetlands that can help store excess water.

Flood Management

Improve Coordination

Several organizations are involved in flood management. Under the supervision of the Ministry of Water and Power, the FFC is responsible for coordinating flood impact mitigation, prevention, preparedness, and response. The PMD assumes responsibility early warnings to national stakeholders, and the armed forces coordinate response measures. NDMA is responsible for coordinating hazard risk reduction, preparedness, and responses to riverine floods, flash floods, and cyclones. PDMA's carry out provincial coordination for flood preparedness which includes inputs from irrigation departments for flood prevention and mitigation and a host of measures involving numerous provincial departments and ministries for preparedness and response. Flood conferences are normally held well before the onset of the flood season and then afterwards to take stock of damage and remedial works.¹⁷ The following is a sum-

16. World Bank. <http://www.worldbank.org.pk> (accessed on 4 December 2011).

17. Government of Pakistan, National Disaster Management Authority. *Monsoon Contingency Plan 2008 final*. www.ndma.gov.pk

mary of the roles of agencies working to control and respond to floods and cyclones:

- NDMA: comprehensive national response to riverine floods, flash floods, and cyclones
- FFC: flood mitigation and response
- PMD: early warnings to all stakeholders of floods and cyclones
- WAPDA: regulates flood water outflow from reservoirs and monitors water flow in catchments areas
- Pakistan Armed Forces: coordinating flood response in aid of provincial authorities
- Emergency Relief Cell: support to reinforce flood response.
- PDMA: disaster management in particular with regard to monsoons
- Flood Forecasting Division (PMD): early warning for riverine floods
- National Crisis Management Cell: reinforces Ministry of Interior emergency response if required
- Civil Defence: local response to floods
- Provincial agriculture departments: flood mitigation works and flood water monitoring
- Provincial health, livestock, Public Health Engineering, food departments: preparedness and response support in respective areas
- Pakistan Agricultural Council: GLOF monitoring and research with ICIMOD

Improve the Early Warning System

One very important aspect of every early warning system is the chosen dissemination method. It is very important that organizations are able to communicate and to cooperate and even more important to let people and other authorities know about relevant developments and dangers. The efficiency of every early warning system will in the end be judged by its output. Dissemination can be divided into two parts—communication among the authorities and communication of the authorities with the population—and further concerns the media used to inform the public.

Collecting data for and the general monitoring of the early warning system happens mainly at the national and the provincial levels. Concerned agencies in Pakistan are provincial irrigation and drainage authorities (PIDAs) and provincial irrigation departments (PIDs), the PMD, and the NDMA. They are in best positions to have an overview for analysing and estimating the actual risks associated with each situation. For localized events such as flash floods, local authorities might have the necessary data to evaluate the situation.

The second step is far more important and far more difficult to achieve as it concerns disseminating information to the broad public. Different methods are used in each district in Pakistan; they are not all of the same calibre. In some districts, information is provided without further explanation while in other districts the authorities use modern communication devices along with traditional means such as sirens, word of mouth, or mosque loudspeakers.

In short, the system lacks a clear structure, and that can lead to the loss of information loss, so this aspect of flood management can be improved. One possibility would be to use mosque loudspeakers to actually inform the public. An alternative would be to use a short message service or radio broadcasts. Any of these systems, when fully implemented, could provide updated information to the public, and a combination would minimize the risk of system failure.¹⁸

18. Japan International Cooperation Agency. 2010. *Progress of National Multi-Hazard Early Warning Plan*. p. 31.

In the late 1990s, an elaborate system was installed with ADB funding but it failed due to lack of coverage in the upper Indus, limited radar coverage, and inadequate coverage for major areas. For example, in KPK the warning time is very short hence the flood damage is more severe so a system for forecasting flash floods is critical. It is important to learn from the capability, effectiveness, and uptake of the existing system to design more specific systems with specific parameters including the following:

- improving meteorology (especially radar);
- recalibrating the hydrologic model for the Jhelum, Chenab, Ravi, and Sutlej watersheds;
- forecasting flash floods; and
- improving radar and meteorological data integration.

National Multi-Hazard Early Warning Plan

There are new efforts under way to establish a multi-hazard early warning system (to be finalized in March 2012) to deal with disasters in a holistic manner. This will be very useful because catastrophic events are often interrelated. For example, tsunamis are usually linked with earthquakes, and landslides are associated with heavy rainfall and dangers of flash floods. Pakistan extends from the Himalaya Mountains to the Arabian Sea, so establishing such a centralized system makes a lot of sense for the following reasons:

- to increase efficiency and reduce the risk of information loss through inter-agency communication;
- to reduce delays between recognizing a danger and acting on it (warning the population);
- to improve the performance of the early warning system itself by recognizing connections between events;
- to provide a comprehensive overview about the current situation to make it easier to make decisions and set priorities; and
- to provide background data for further research.

Currently, most of the early warning infrastructure in Pakistan is outdated. There are various projects to upgrade the equipment, but it would be preferable to set up an extensive multi-hazard system that covers all dangers. NDMA is currently collaborating with the Japan International Cooperation Agency (JICA) to do just that. Of primary importance is to learn from the floods of the last 20 years and analyze the system in practice. The following measures will be taken against recurring hazards.¹⁸

- | | |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Tsunami: | (i) establish a monitoring network for tide levels including a data communication system, (ii) provide training using tsunami simulations, and (iii) prepare hazard maps. |
| River floods: | (i) make satellite forecasts and hazard maps of the Indus River system, (ii) replace existing meteorological radar stations including data communication systems, (iii) establish regional flood forecasting and warning centers, and (iv) establish a rainfall and water level observation network. |
| Flash floods: | (i) establish local flash flood forecasting centers, (ii) finalize hazard maps and develop capacity to eliminate flash floods and landslides due to heavy rainfall, (iii) prepare landslide hazard maps, (iv) expand the automatic weather observation network including a communication system for preparing hazard maps. |
| Cyclone and storm surges: | (i) expand the automatic weather observation network and the communication system, (ii) establish a monitoring network for tide levels including a data communication system shared with other early warning |

- systems, and (iii) replace the Karachi Meteorological Radar Station and the shared data communication system.
- Drought: (i) establish a specialized, medium-range forecasting center, and (ii) expand the automatic weather observation network including a communication system for drought monitoring
- Others: (i) establish an early warning system for GLOF's in Gilgit-Baltistan including hazard maps, (ii) enhance research on snow/glacier/glacial lakes.

Post-flood Activities

National Service for Embankment Safety Review

There is a need for strengthening the monitoring role of the FFC in coordination with the engineering directorate and the custodians of flood protection infrastructure (e.g. Provincial Irrigation Departments) to review the condition of the flood embankments after each major flood to prioritize restoration options.

Build Forecasting Capacity at PMD

Training workshops on hydrological forecasting need to be conducted to train flood forecasting experts at PMD. These workshops will focus on model calibration and will aim to provide forecasters with the capacity to perform future model recalibrations and validation studies between the forecasting seasons.

Priority Projects

Revised National Flood Protection Plan (IV)

The fourth plan was prepared by the FFC in 2006; however it was not approved due to the low priority given to floods before 2010. The plan has since been revised and updated with an estimated cost of PRs 50 billion (\$500 million) as per the following table. We recommend that the structural and non-structural measures described in this report should also be included in the revised plan and implemented as a matter of priority (Table 4.1)

Table 4.1: Updated Investments for National Flood Protection Plan-IV

Category	Province/Region	Agency/Province Estimated Cost (PRs billion)
Flood protection and mitigation	Punjab	18.75
	Sindh	12.92
	Khyber Pakhtunkhwa	4.58
	Balochistan	3.33
	Gilgit-Baltistan	0.42
	FATA	1.25
	AJK	0.42
Upgrading and expanding the forecasting and early warning systems	WAPDA	0.98
	PMD	3.67
Research, mapping, zoning, feasibility studies, monitoring equipment and capacity building	FFC, Capacity Building, Consultancy Services	3.69
Total:		50.00

The funding requirements in (I) for provinces and federally administered areas mainly represent flood protection infrastructure (flood embankments/dikes/levees, spurs, flood dispersion and detention structures, economic incentives), flood relief/escape channels (wherever feasible) and procuring heavy equipment for flood mitigation activities of around PRs5 billion on a prorated basis for all stakeholders.

Estimates for WAPDA and PMD (II) are for upgrading and expanding the existing flood forecasting and warning system by procuring and installing additional weather radar. Greater coverage will be given to WAPDA's flood telemetry system for hydrological measurements including GLOF monitoring.

Cost estimates for FFC (III) include automated monitoring mechanisms, upgrading the Flood Communication Cell, floodplain mapping and zoning, sediment and erosion studies considering changing sediment loads in the rivers (river morphology studies) and other research studies including feasibility studies for flood protection infrastructure and supervision through consultants to be executed by the provinces and federally administered areas under (I). Capacity building efforts under (III) supervised by the FFC for all stakeholders will include on-the-job training of senior and mid-level managers; exposure to new flood management/mitigation techniques; and diploma and postgraduate studies and exchanges of interns and researchers through joint programs with international centers of excellence such as the International Center for Integrated Water Resource Management in the USA, the United Nations Educational, Scientific and Cultural Organization's (UNESCO) Institute for Water Education (IWE), and the International Centre for Water Hazard and Risk Management (ICHARM).

Priorities for Implementation

The following activities may be included in the revised fourth plan and are reproduced here as a minimum to implement in the absence of the larger plan.

Innovative pilot projects for flood management: There is a need to introduce innovative structural and non-structural approaches to complement traditional flood management practices. This initiative will introduce pilot projects in line with local requirements and new techniques (sheet piling, interlocking blocks, rubber dams, forestation, economic incentives for relocating vulnerable populations, soil and water conservation and runoff-reducing crops, check/detention dams, flood management/dispersion structures in hill torrents developed in flood prone countries). Implementing agencies will be the PIDs, federal line agencies and universities (\$10 million).

Community-based activities: Community outreach by union councils is needed to raise awareness and build basic knowledge and understanding of local vulnerabilities and capacities, to prepare disaster management maps, to form community disaster management committees, and to enhance preparedness and emergency response capacities. By increasing the resilience of communities, deaths and injuries and secondary disasters will be minimized. After the 2005 earthquake, pilot activities for union councils were conducted and instructor's guidelines were developed. There are eight modules that can be utilized.

Multi-hazard early warning system: Pakistan is vulnerable to natural disasters from a range of hazards including floods, cyclones, drought, earthquakes, GLOFs, landslides, avalanches, and tsunamis. Plans prepared by agencies in the past have been unified under the NDMP umbrella plan for the next 10 years. The statuses and conditions of current early warning systems were

scrutinized from observation activities to communication methods, then gaps and challenges were described. Based on that analysis, actual projects and programs were proposed with target years and goals. Activities are classified into six steps: observation, prediction/forecast, dissemination, judgment/direction, communication/action, and recording. Related activities include coordination, awareness, education, and risk analysis. At each step and related activity, the responsible agencies are the federal government and the FFC, NDMA, PMD, the Geological Survey of Pakistan, WAPDA for project implementation and the provincial government and DMAs, PIDs and PIDAs for irrigation.

The implementation of the proposed projects has been divided into three phases: short to medium term, long term, and super-long term (more than 10 years). The total cost of proposed projects in the first 5 years is \$500,000,000 including infrastructure rehabilitation, installing equipment such as radar, establishing systems for each type of disaster, enhancing and strengthening human resources and capacity development for PMD/DMAs/communities as well as preparing large-scaled flood inundation and hazard maps of vulnerable areas.

National Disaster Management Plan

The national framework was prepared by NDMA in March 2007 to serve as an overall guideline at the national, provincial and district levels until 2012, so there is a need to establish overall guidelines for disaster risk management. The National Disaster Management Plan (NDMP) includes (i) a human resource development plan, (ii) a community-based disaster management plan, (iii) a multi-hazard early warning system, and (iv) an action program for disaster management at the federal level. A JICA study team was mobilized in April 2010 to formulate the national plan and other disaster management plans. The national plan involves NDMA, PMD, and FFC nationally and DMAs in provinces and districts. The estimated cost of the project is about \$5 million in grant aid.

Review Flood Management to Improve Planning

The review will help to identify difficulties arising from past forecasting and management practices, the discharge capacities of the barrages/headworks/bridges and needs for remodeling, the best practice in locating and operating the breaching sections, and pathways for implementing the legal aspects of floodplain zoning and integrated flood management.

The will aim is to facilitate understanding of technical and policy issues in flood management through major infrastructure; to examine how advanced modeling should support planning, design, operation, and maintenance of flood defense systems; and to identify methods and procedures for implementing IFM and for using flood waters beneficially. The Ministry of Water and Power, WAPDA, and PMD will act as lead institutions with the contribution and collaboration of IRSA. The anticipated cost is \$2 million.

Update Existing Flood Forecasting and Early Warning Systems

This project aims to improve the accuracy and quality of forecasts through the following activities: (i) recalibrating the hydrologic model recalibration for the Jhelum, Chenab, Ravi, and Sutlej watersheds; (ii) including flash floods from nallahs; (iii) improving the meteorological (especially radar based) input into the forecasting of flash flood systems; and (iv) improving radar and meteorological data integration within the system. Key partners include PMD, the FFC, NDMA, and UNESCO, especially the International Hydrologic Programme, IWE, and ICHARM. The anticipated cost of the project is \$10 million.

PRODUCTIVE SECURE AND SUSTAINABLE CITIES

Introduction

The rapid growth of cities is a common and persistent demographic phenomenon in most developing countries including Pakistan. This growth has led to an increase in urbanization. In Pakistan, for instance, the proportion of total population living in urban areas increased from only 17.4% in 1951 to about 32.5% in 1998, and the urban population is projected to equal the rural population by 2030.

Apart from other social challenges, urbanization in Pakistan also poses serious threats to already stressed basic amenities including water and sanitation facilities. Most urban settlers rely on groundwater that is rapidly being depleted, and only about 1% of all sewage is treated. In addition, water utilities are running under ever growing deficits due to poor revenue recovery, so service delivery is poor. Under the current appalling situation, it is unlikely that water and sanitation services can be continued on a sustainable basis. There is, therefore, an urgent need to address the situation.

Development Options

Table A5.1 lists priorities for action for four provinces according to whether the provincial government has demonstrated the political will to consider major reforms (Type A) or has not done so (Type B).

Table A5.1: Development Options for Four Provinces

Development options for Type A provinces	
Punjab	Khyber Pakhtunkhwa
<ul style="list-style-type: none"> • Prepare and enact the Punjab Municipal Water Act. • Incorporate water and sanitation authorities (WASAs) and institute a performance-based management contract for WASA managers. • Develop a mechanism for automatic annual tariff revisions based on inflation. • Initiate steps to reduce non-revenue water (NRW) • Develop and implement measurements and regulations for ground water abstraction. • Control industrial discharge into natural bodies beginning with the most contaminating industries/activities 	<ul style="list-style-type: none"> • Create a single WASA merging all water service entities except the cantonment board (the process is being facilitated by the World Bank and the United States Agency for International Development [USAID]). The government has shown its commitment and willingness) • Develop a mechanism for automatic annual tariff revisions based on inflation. • Develop and implement measurements and regulations for ground water abstraction • Initiate steps to reduce NRW.
Development options for Type B provinces	
Sindh	Balochistan
<ul style="list-style-type: none"> • Initiate benchmarking between WASAs based on a few key indicators. • Initiate steps to reduce NRW. • Prepare and implement a customers' relationship strategy. • Develop a mechanism for automatic annual tariff revisions based on inflation. • Control industrial discharge into natural bodies beginning with the most contaminating industries/activities. • Develop the existing Sindh Cities Improvement Project financed by the Asian Development Bank (ADB) (cluster of cities in Sukkur run by an autonomous company). 	<ul style="list-style-type: none"> • Save the ground water aquifer (1 000 feet deep, 7 feet depletion/year) by dramatically reducing pumping from irrigation tube wells. • Initiate steps to reduce NRW • Develop a mechanism for automatic annual tariff revisions based on inflation.

Actions Common to All Four Provinces

Develop a Mechanism for Automatic Tariff Revisions

Table 5.2 presents the rationale for this action.

Table A5.2: Rationale for Automatic Tariff Revisions

Q: Why is this an immediate priority?

- A: Currently there is no systematic/automatic mechanism for water and sewer tariff revisions. Every water utility petitions to revise tariffs periodically to cover inflation and other cost increases. The petitions are often turned down largely due to political reasons.
- Without exception, revisions are long overdue despite high annual inflation (10%–12%), doubling of energy costs in recent years, and ever growing employee benefits each year (Lahore last revised in 2004, Faisalabad and Rawalpindi in 2006, Karachi Water and Sewerage Board (KW&SB) in 2010 after 10 years).
 - National and provincial drinking water policies envision “Provision of drinking water of an adequate quantity at an affordable cost through equitable, efficient and sustainable services.” This vision could be realized only if water utilities are allowed to run on sound business principles and are allowed to go for cost recovery for the services provided through an automatic, transparent, and consumer-responsive tariff revision mechanism.

Q: How will outcomes change if this is done?

- A: Current financially ailing utilities would become financially sustainability (Lahore’s WASA covers only 70% of costs and KW&SB spends almost twice what it recovers).
- The Japan International Cooperation Agency (JICA) Master Plan Study for Karachi argues that, “All the problems either directly or indirectly emanate from financial constraints.” Periodic tariff revisions with proper indexation will pave the way to bring water utilities out of a vicious circle (financial constraints, poor quality service, consumer dissatisfaction, greater reluctance to pay).

Q: How is the problem addressed currently?

- A: Tariff revisions have been proposed by the respective utilities based on their costs and sent to their governing boards for approval. Even if the boards approve, however, they cannot be implemented if not approved by provincial government(s) which usually does not happen.
- The result is that accumulated deficits continue to grow (around Pakistan rupees [PRs]20 billion for KW&SB) and dependence on government subsidies increases every year while service continues to deteriorate.

Q: What is wrong with the current method?

- A: As above

Q: What specific approach/ models should be used?

- A: Apart from taking other parallel measures (cost reductions, improving revenue collection efficiency) a yearly tariff revision model should aim to respond to inflation for at least the two main cost components (electricity and manpower). For example, if electricity costs account for 40% of expenditures, a 20% annual increase in this cost would lead to an 8% increase in the water tariff.

Q: What institution is or should be responsible?

- A: Water utilities (WASAs/KW&SB), provincial housing and urban development departments, the Public Health and Engineering Department (PHED), finance departments.

Q: Does the leadership of the institution consider this to be a high priority and if so, why has not it been done?

- A: Agreement in total.

Q: How much would such a program cost over the next 5 years and where would the resources come from?

A: The cost would not be great if most of the homework is done by the respective utility though some technical assistance could be needed for a professionally robust study/mechanism to account for a broader consensus of all stakeholders. A recent study (tariff road map) on Lahore's WASA by JICA could be used as a starting/reference point.

Q: What help is needed? Legislation, Human resources, Technical/partners/study tours.

A: No legislation is required.

- Rules and regulations could be amended by the utilities to collect and document reliable data in a transparent way that could be used as a base for tariff revisions.
- Proposed technical assistance could include a training module in tariff revision for the staff involved.

Initiate Steps to Reduce Non-Revenue Water

Table A5.3 presents the rationale for this action.

Table A5.3: Rationale for Reducing Non-Revenue Water

Q: Why is this an immediate priority?

A: The percentage of water produced that does not bring in revenue ranges from 30% to 45% (Lahore WASA=35%, Gujranwala WASA>45%).

- Already financially ailing water utilities are being further deprived of much-needed revenue due to lost water and must spend more than necessary on energy costs for transmitting, and distributing water.
- There is a complete absence of a control system for leaks, so few if any efforts are made to reduce NRW.

Q: How will outcomes change if this is done?

A: Water saved could be diverted to currently unmet demands by domestic users (population not served in Lahore is 12% and in Faisalabad is 40%) as well as for other competing usage (commercial and industrial).

- NRW reduction efforts will bring in more revenue by expanding the consumer base when illegal users become part of the consumer network and by increasing available water (potentially by 20%–30% if half the current NRW is recovered).
- The need for capital investments to develop water resources to fill the gap between demand and supply would be reduced.

Q: How is the problem addressed currently?

A: NRW ranges from 30%–45% in most of water utilities. For smaller utilities it is even greater. In the absence of metering of water production and distribution (with the exception of Lahore WASA with 16% of water connections metered), the figures on NRW are estimates.

- Deferred maintenance and aging water systems (pipes in some cases are 50 years old in Karachi and in other cities) are further degrading the situation causing ever increasing water wasting and high NRW.

Q: What is wrong with the current method?

A: As above

Q: What specific approach/models should be used?

A: Various models for reducing NRW are practiced globally, but the WSTF suggest the following simplified approach:

- Commence by taking very basic steps comprising doable actions by the respective utility. Start with a consumer baseline survey to update the database and identify illegal connections. The Faisalabad WASA last conducted one in the early 1990s, Lahore WASA did one 10 years ago, and the others have never conducted one. The next step is to address visible leaks from distribution networks and storage reservoirs and also to conduct precise mapping of subterranean networks (trunk and distribution mains along with control systems and valves).
- Following this, a more sophisticated phase could start by employing leak detection equipment and establishing hydraulically isolated zones and universal metering.

Q: What institution is or should be responsible?

A: Water utilities

Q: Does leadership of the institution consider this to be a high priority and if so why has not it been done?

A: Agreed in principle but little or no efforts are being made. This can primarily be attributed to a lack of accountability and unclear responsibilities with respect to service standards.

- More sensitization among utility managers and a proactive approach is needed.

Q: Does leadership of the institution consider this to be a high priority and if so why has not it been done?

A: Agreed in principle but little or no efforts are being made. This can primarily be attributed to a lack of accountability and unclear responsibilities with respect

to service standards.

- More sensitization among utility managers and a proactive approach is needed.

Q: How much would such a program cost over the next 5 years and where would the resources come from?

- A: The initial basic steps (consumer baseline survey, re-pairing visible leaks from networks and storage tanks, metering all raw water sources) require relatively modest investments ranging from PRs10–20 million per utility.
- Moving toward the next phase of procuring leak detection equipment, implementing distribution network improvements, and forming hydraulically isolated zones may require substantial investments.

- For the initial phase, funding could be arranged by the provincial governments or could even come from the utility's own revenue source and later be supplemented by the government.
- After a successful initial phase, donors could be approached for financing for the next phase.

Q: What help is needed? Legislation, Human resources, Technical/partners/study tours.

- No legislation is required.
- Special teams of existing human resources focused on specific objectives should be formed.
- Training and capacity development should be continuous; donor assistance may be sought for this.

Develop and Implement Regulations/Measurements for Groundwater Abstraction

Table A5.4 provides the rationale for this action.

Table A5.4: Rationale for Managing Groundwater Abstraction

Q: How will outcomes change if this is done?

- A: There are no regulations for monitoring or regulating the abstraction of groundwater despite the fact that the piped water supply in Punjab largely depends upon groundwater (Lahore, Multan, Gujranwala WASAs 100%, Faisalabad WASA 90% and Rawalpindi 40%). The same is true for Khyber Pakhtunkhwa (KP) and Quetta.
- The absence of any robust regulations encourages groundwater abstraction particularly in sweet water zones. For instance, there are thousands of private tube wells/bores used by industries and for irrigation (more than 10,000 in Lahore District alone). As a result, the aquifer in Lahore is dropping 2–3 feet per year).

Q: How will outcomes change if this is done?

- A: There is no systematic way to monitor the extent of groundwater abstraction. Despite the fact that a large percentage of tube wells are metered (Gujranwala WASA and Multan WASA 80%, Lahore WASA 50%), these meters are seldom read or documented. In most cases, water abstracted is estimated by multiplying the number of operational hours by the designed capacity of the wells (disregarding the age of the machinery), and for private irrigation tube wells measurements are absolutely non-existent.
- Some cities (Faisalabad, Rawalpindi and Lahore indirectly as sewer discharge) levy aquifer charges on private tube wells, yet the motivation and extent is

erratic, and implementation is very loose; the result is an ever increasing number of tube wells.

Q: How will outcomes change if this is done?

- A: Better control over the groundwater abstraction will achieve a sustainable water balance.
- Ground water depletion will be reduced.

Q: How is the problem addressed currently?

- A: No concrete action is being taken despite the awareness among relevant professionals.
- Many studies, including the JICA Master Plan for Lahore and a recent study done for the Rawalpindi WASA indicate the same alarming situation.

Q: What is wrong with the current method?

- A: There is no control over the installation of new tube wells or as checks/limitations on the quantity withdrawn.
- A scarcity of surface water for irrigation is further aggravating the situation.

Q: What specific approach/models should be used?

- A: Assess the current water balance and safe abstraction potential of the aquifer.
- Identify the amount of current abstraction particularly by the private sector (industries and commercial entities and irrigation tube wells).
 - Implement control measures like levies, aquifer charges, penalties in accordance with the proposed regulations.

Q: What specific approach/models should be used?

- A: Curtail public funding for irrigation tube wells for agriculture.

- Look for alternate mid-term options for urban water supplies.

Q: What institution is or should be responsible?

A: WASAs, provincial irrigation department, PHED

Q: Does leadership of the institution consider this to be a high priority and if so why has not it been done?

A: Largely in agreement

Q: How much would such a program cost over the next 5 years and where would the resources come from?

A: The cost would not be substantial as only rules and regulations must be formulated and implemented.

Q: What help is needed? Legislation, Human resources, Technical/ partners/study tours.

A: Legislation is required to effectively control over-exploitation of groundwater.

Actions for Punjab and Khyber Pakhtunkhwa Provinces

Prepare and Enact Punjab Municipal Water Act

Table A5.5 provides the rationale for this action.

Table A5.5: Rationale for the Punjab Municipal Water Act

Q: Why is this an immediate priority?

- A: In Punjab there is no water supply or sewerage act so the responsibilities of relevant service providers are not clear.
- In the absence of any regulatory framework, service providers are not fully accountable to either their customers or to their financiers (government)
 - Utility managers have to interact with a number entities that have advisory powers (planning and development (P&D) board.), administrative powers (Housing Urban Development [HUD], PHED and district administrations), political powers (district Nazims/members of parliament), or sanctioning powers (finance department, HUD, and PHED).
 - Huge overlaps and a lack of clarity in responsibilities among water utility managers and interrelated agencies call for more stringent legislation.

Q: How will outcomes change if this is done?

A: The managers will conduct their operations with high commercial and sound professional standards without external interference resulting in improved, sustainable, and reliable water and sanitation services.

Q: How is the problem addressed currently?

- A: The utilities have no autonomy and are regularly subject to a great deal of external interference in their operations and financing. The result is financially ailing utilities and deteriorating service quality.
- Utilities are run on a day-to-day basis mostly fighting fires while responding to various lines of commands.

Q: What is wrong with the current method?

- A: As above
- The high level of receivables leads to insufficient revenues making the utility more and more dependent on subsidies even for operating expenses. Currently operating expenditures are greater than operating income.

Q: What specific approach/models should be used?

- A: Enact the Water Act.
- Incorporate the WASAs.
 - Create an independent regulator to act as a watchdog.
 - Adopt management contracts with a strong focus on service delivery (billing, distribution, collection, operations and maintenance) in a phased manner.

Q: What institution is or should be responsible?

A: Provincial political leadership (legislative assembly), HUD, and PHED

Q: Does leadership of the institution consider this to be a high priority and if so why have they not done it?

A: Largely in agreement to make the respectively utilities more autonomous, customer responsive, and more accountable.

Q: How much would such a program cost over the next 5 years and where would the resources come from?

- A: The cost would be seed money only as mostly regulations are initially required. The provincial government may allocate money through its annual development program.
- Most of the major donors (World Bank, JICA) have the same recommendations in their recent studies and could be approached for larger investments once there is strong political will to reform.

Q: What help is needed? Legislation, Human resources, Technical/partners/study tours.

- A: Legislation is required
- Training and capacity development should be continuous; donor assistance may be sought.
 - Top and mid-level managers are required. In Punjab

WASAs, directors are already hired competitively that needs to be further consolidated and deepened with the hiring of second line of managers in all sub-units, i.e., engineering finance operations, etc.

Save Quetta Ground Water

Table A5.6 provides the rationale for this action.

Table A5.6:
Rationale for Saving Quetta's Groundwater

Q: Why is this an immediate priority?

- A: Ground water balances in the Quetta sub-basin in 2000 and 2010 showed a systematic and increasing deficit between water consumption and recharge. The shortfall now amounts to 50% if only the alluvial aquifer is considered and to 12% if the hard rock limestone aquifer is considered as well.
- In 2000, the deeper limestone aquifer was not exploited. Now it accounts for 23% of the abstraction in the basin. Depending on the location, the water table in the limestone aquifer has dropped an average of 4–9 meters annually from 2003 to 2007.
 - The higher alluvial aquifer has more or less lost its buffer capacity. Water tables in the alluvial aquifer have fallen from 1–3 meters annually since 2003! Natural recharge (~ 38 million gallons/day) is half of current abstraction; most is still for irrigation.
 - If nothing is done, Quetta will change from a thirsty city to a ghost city.

Q: How will outcomes change if this is done?

- The depletion will be stopped; the pumping costs will stabilize.
- Quetta City will be better able to face its high current population growth rate (natural and migrants).

Q: How is the problem addressed currently

- A: Several technical reports warned the authorities:
- KW Consult and Louis Berger, Quetta Water Supply and Environmental Improvement Project 2000
 - World Bank's Groundwater Management Advisory Team (GW-MATE) and Integrated Water Resource Management
 - Technoconsult/Cameos, groundwater management action plan for Pishin Lora and implementation of the pilot plan for Quetta sub-basin, 2011
 - No real action has been taken; political interference degrades the situation.

Q: What is wrong with the current method?

- No priority is given to ground water sustainability.
- No action is taken to reduce pumping for agriculture even though there is a large overdraft.
- Electricity costs for irrigation tube wells are highly subsidized (farmers pay around 10% of the real cost); bill collection is low.
- No effort made to maximize ground water recharge for Quetta in a cost-effective way

Q: What specific approach/ models should be used?

- Close down and compensate farmers for a large portion of irrigation tube wells. The current informal rate for buying someone's connection (including equipment) is PRs650,000 (\$8000). Based on this figure, a compensation program would cost approximately \$10 million.
- Some of the agricultural wells could be sourced to the city. This appears to be a cheaper solution than distant surface water sourcing.
- Continue to strictly enforce the ban. Do not allow new irrigation tube wells, and stop any public funding for constructing and/or operating agriculture wells.
- Invest in a wide range of cost-effective recharge and retention measures such as subsurface dams, low-cost injection wells, spate irrigation, catchment protection, and check dams.
- Comprehensively address reducing NRW. (WASA, PHED)
- Also, if required, consider buying water from nearby surface irrigation systems particularly in Hanna/Urak as an alternative or complement to the current proposed surface water projects
- such as Mangi Dam (60 kilometers [km] away, a PRs6 billion investment, 7 million gallon/day supply after conveyance losses i.e., 25 % of existing urban consumption).

Q: What institution is or should be responsible?

- Chief minister, execution by P&D, irrigation departments, PHED including WASA in coordination with Military Engineering Services (MES) and nongovernment organizations (NGOs)

Q: Does leadership of the institution consider this to be a high priority and, if so, why has not it been done?

- In agreement, sensitive political issue
- This vital issue was raised in the Friends of Democratic Pakistan (FODP) Water Sector Task Force (WSTF) steering committee by the Balochistan representative

Q: How much would such a program cost over the next 5 years and where would the resources come from?

- This has yet to be assessed, but a rough estimate is PRs3.5 billion (buying wells, recharging investments)
- Donors will certainly assist if a principle decision is made.

Q: What help is needed? Legislation, Human resources, Technical/partners/study tours.

- Effective engagement is needed with the stakeholders and well owners to enforce of the Quetta Ground Water Sub-Basin Plan.
- Professional human resources will be needed to develop an investment program with a broad range of recharge measures (more than delay action dams only).
- Effectively enforce the ban on new tube wells and extend it to the deepening of existing tube wells.
- Multilateral donors can share similar experiences in semi-arid areas (Iran, Kenya, Yemen).

Tackle Industrial and Other Contaminations (Lahore)

Table A5.7 provides the rationale for this action.

Table A5.7: Reduce Pollution in Lahore's Water Supply

Q: Why is this an immediate priority?

- A: There is an immediate threat to public health through chemical and biological contamination of water bodies through open air drainage of all kind of sewage.
- In all, 800 steel mills north of Lahore are depositing their waste water without treatment in open air channels, and uncontrolled and untreated deposits are seeping directly into the aquifer through infiltration wells from the 219 units in the west of Lahore.
 - Waste water from India is conveyed to the Ravi River in the Hudiara drain together with untreated waste of 300 textile units.
 - All hospital sewage is deposited in open drains. Highly infectious waste is not separated and is hence very harmful.
 - About 1000 hectares of crops (mainly vegetables) are irrigated with untreated waste water.
 - Two landfills are proposed in the flood area of the Ravi River.

Q: How will outcomes change if this is done?

- A: High expenditures for treating water borne diseases can be avoided or reduced
- Production costs may be reduced in future as it is always cheaper to avoid throwing substances into the water than it is to get them out afterwards. Products may be eligible for export to countries that impose thresholds for ecologically sound production.
 - In this light, production may be revised and cost effectiveness can increase for the enterprise by changing patterns. The effects can be an incentive for better environmental behavior.

Q: How is the problem addressed currently?

- A: No real action has been taken yet (out of 18 pre-treatment plants only 6 are active).

- Environmental rules are set up but no control or enforcement is evident.
- Inspections by the environmental protection agency (EPA) can be done only with 2 days advance notice.
- The Program for Industrial Sustainable Development (PISD) with Dutch funding has been in operation since 1994 as a public-private partnership in Sindh and Punjab (Lahore) helping several sectors of industry to produce in accordance with National Environmental Quality Standards (NEQS) and ISO 14,000 standards

Q: What is wrong with the current method?

- A: The economy of cheap production costs comes at the expense of degrading the environment and the health of the people and hence quality of life.
- No real enforcement of environmental laws exists; sanctions are often not executed.
 - No awareness exists about the danger of depositing highly infectious sewage in common drains and therefore no remedial actions are enforced, and no funds are assigned to mitigate the situation.

Q: What specific approach/models should be used?

- A: Separate highly infectious waste water from normal sewage in hospitals and (pre-)treat hospital waste water starting with private hospitals
- Promote Quaid-e-Azam Industrial Estate common effluent treatment plants (379 units, there are already 6 pre-treatment facilities). Scale up interventions in the framework of PISD II in Sundar Industrial Estate Raiwind in Lahore.
 - Investigate if recycling in certain industries may increase cost effectiveness. This may be an incentive for pre-treatment. Install pre-treatments tailor made for the specific industry and monitor the effluents.
 - Assist industries to investigate better or modified production processes that will avoid or reduce emissions

- of harmful substances.
- Pre-treat waste of textile industries in the south and steel mills in the northern parts of the city. Collect the waste water and pre-treat that of the 219 units in the west of the city.
- Allow the immediate, unannounced access of EPA inspectors to every polluter

Q: What institution is or should be responsible?

A: EPA, WASA in coordination with MES and industries, Ministry of Education, Municipality of Lahore

Q: Does leadership of the institution consider this to be a high priority and, if so, why has not it been done?

- A: In agreement, sensitive political issue
- The cost intensive processes of waste water treatment are considered counterproductive to the overall aim of maximizing profits.
 - Sufficient awareness is not present at any level of the secondary costs in public health and the long-term costs of degrading the environment and deteriorating resources.

Q: How much would such a program cost over the next 5 years and where would the resources come from?

- A: The cost has yet to be assessed depending on participating industries and the character of hospitals.
- Industry should shoulder the operating and capacity costs. Donors will certainly assist if a principle decision is made.

Q: What help is needed? Legislation, Human resources, Technical/partners/study tours.

- A: Effective engagement of the agencies enforcing the law will be needed. Fines should be designed so they are always higher than the gains caused by the infraction.
- Human resources will be required for developing investment programs to optimize production and avoid unnecessary deposits of substances in that damage health or the environment into the water supply.
 - Mobilize professional human resources for developing and implementing optimal treatment processes for waste water.

Background for the Proposed Action Plan

To gain a better understanding of their realities and challenges, our urban team visited water and sanitation agencies at each provincial capital and at the federal capital (CDA) in addition to other agencies responsible for services in Rawalpindi and Faisalabad in Punjab Province and Hyderabad in Sindh Province. Provincial HUD, PHED, and P&D departments were also visited. We had extensive exchanges with the key managers and administrators to identify real challenges and their causes and implications and to formulate plans based on concrete, doable actions as eventual outcomes.

The Current Situations of the Water Utilities

Table A5.8 illustrates the key challenges a typical utility confronts along with the main causes and possible impacts.

Table A5.8: Typical Challenges Faced by Water Utilities, Their Causes and Impacts

Challenges	Causes / impacts
Unsustainable utilities	<ul style="list-style-type: none"> Infrequent tariff revisions (last increase dates back 7–20 years) Electricity costs are 35%–55% of operations and maintenance, bills are only partially paid (adjustment parameter of the accounts) Deferred maintenance due to lack of liquidity Increased reliance on subsidies from the province Low collection rates (from 20% to 82% is fair performance for Rawalpindi and Lahore) Low water tariffs (between 1% and 2% of average household income) Parallel service providers (tankers, donkey carts, water vendors)
Poor customer service	<ul style="list-style-type: none"> The consumer not considered a client Few competent staff dedicated to client attention Poor call centers and customer complaint statistics (good steps forward in Rawalpindi) Resulting reluctance of customers to pay bills (particularly strong in Karachi) Unpredictable intermittent water supply

Challenges	Causes / impacts
High non-revenue water	<p>A lot of illegal customers (from 10% to 35% of consumers)</p> <p>Visible leak repair not a priority</p> <p>Unmetered consumption generates waste by customers</p> <p>No precise estimate of NRW (poor metering): range is 30% to 45% in quantities of water before taking into account the collection rate</p> <p>Total lack of action plan to reduce NRW</p>
Human resources	<p>Managers know their jobs, their staff, their facilities</p> <p>Lack of motivation due to lack of evaluation and lack of finances</p> <p>No incentives (except for bill collectors in the best WASAs), no hiring and firing power for managers</p> <p>All managers complain about daily political influence (rare that subsidized investments come with an already decided project, hiring of unnecessary staff)</p> <p>Overstaffing</p> <p>No compass: no performance indicators (except in Punjabi WASAs, World Bank Water and Sanitation Program [WSP])</p> <p>Almost no training</p>
Poor water quality	<p>Tap water is not potable (frequent bacterial contamination)</p> <p>The filtration plants visited are correctly run, water is disinfected</p> <p>Tube wells lack chlorination in many places</p> <p>Intermittent supply generates depression in pipes and contamination in the network (increased by use of sucking pumps by customers)</p> <p>Good practice of mini filtration plants in certain cities (WASA supplies gratis safe water by locally re-treating piped water, in 132 units in Rawalpindi)</p> <p>National standards exist (NEQS) for sampling and water analyses in every city</p>
Water quantity	<p>Not the main bottle neck: production per capita remains high despite population growth (3% to 5%), except in Quetta</p> <p>Depletion of ground water table is an important issue in some cities</p> <p>Bulk production is virtually not measured</p> <p>Non-existent domestic metering except in Lahore (16% of customers)</p> <p>Industries pump mainly ground water without any control</p>
Sanitation	<p>Almost no effluent treatment, except CDA (15% of effluent treated, capacity 30%, good technical management) and Karachi (15% of treatment capacity, rehabilitation needed for 1 of the 2 plants)</p> <p>Various treatment processes: activated sludge, trickling filters, anaerobic ponds, stabilization ponds</p> <p>Nearly all effluents flow to natural bodies (rivers, drains, canals, water table)</p> <p>A lot of solid waste in drains, canals, and collectors</p> <p>Insufficient sewerage network in many areas</p> <p>Almost no collector repairs</p> <p>Jetting vehicles available to solve collector blockages</p>

Source: WSTF Urban Team compilation using WASA data and information gathered from interviews and site visits.

Table A5.9 provides key figures and indicators for major urban areas.

Table A5.9: Key Indicators for Major Urban Areas

	Islamabad	Rawalpindi	Karachi	Lahore	Quetta	Peshawar
Population						
Total (thousands)	800	1,300	18,000	5,900	1,500?	1,800?
Connected to water network (%)	-	90	90	89	-	-
Connected to sanitation network (%)	-	35	59	86	-	-
Past average growth rate (%)	3	3.5	4.2	3	-	-
Drinking water						
Production/day x capita connected (gallons/liters)	87/400	39/175	32.5/150	64/290	20/90?	-
Average service hours / day (h)	3	9	5	16	2	3
Metered connections (%)	0	0	0	13	0	0

	Islamabad	Rawalpindi	Karachi	Lahore	Quetta	Peshawar
Customer service						
Average tariff (PRs/gallon PRs/cubic meter)	-	0.024/5.2	0.01 /3	0.015/3.5	0.03/7?	-
Collection rate (%)	90?	82	64	80	20	-
Human resources						
No. of employees/1000	2,000	1,100	13,030	6,560	2,340	4,740
Water connections	36	12	19	11	33	59
Financial data (2010 / 2011)						
Electricity costs total expenditure costs (%)	-	34	52	43	-	-
Operating cost balance = revenues–expenditures (million PRs)	-1,900	-190	-2,700	-1,700	-760	-620
Deficit per water connection (PRs)	-34,545	-2,094	-3,857	-3,014	-10,800	-7,000

An assessment of the information in Table A5.9 leads to the following comments.

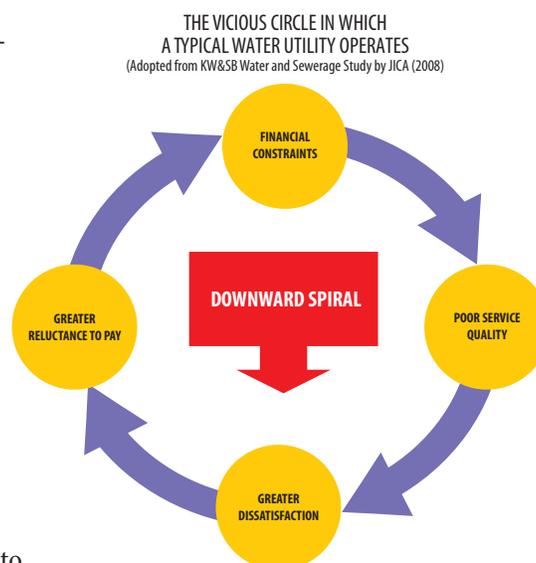
- The population statistics are dubious especially in Quetta and Peshawar where the arrival of migrants makes the numbers uncertain (the last national census was conducted in 1998).
- All data are related to utility service areas and exclude cantonment boards.
- Financial deficits are growing year after year. Some WASAs like Rawalpindi had balanced operation and maintenance accounts in the past.
- There are strong differences between utilities in hours of pumping and bill collection.
- Overstaffing is the common trend; the ratio per 1,000 water connections ranges from 11 to 59 while the European average ranges from 2 to 4.
- The drawbacks of overstaffing are the difficulty in managing too many people (e.g., the KW&SB Technical Director has to manage 10,000 employees) and high salary expenditures (the second highest after electricity)

Non-Revenue Water

Non-revenue water (NRW) is unbilled water; it is estimated at between 30% and 45% though no accurate calculations are possible because there is no systematic metering at production and distribution points. Coupled with collection inefficiency, the water effectively paid for by the customers range from 16% of production in Quetta to 52% in Rawalpindi and Lahore.

The best source for financial recovery is better customer management (billing illegal connections, improving collection rates) rather than reducing physical leaks though both must be addressed. Increasing NRW is forcing water utilities on a downward spiral into the vicious circle illustrated in the adjacent figure.

The key to breaking this circle and creating an upward spiral is to reduce customer dissatisfaction by providing better service, though this will take several years. Under existing conditions, better service means predictable and equitable rationing hours, opening communication channels to allow customers to



contact the utility, and solving administrative and technical problems raised by the clients. International experience shows that reluctance to pay has nothing to do with the level of income of households and that if the quality and fairness of the service increases, the reluctance to pay is reduced. The following are simple measures that a utility can undertake on its own without any legal interventions or a heavily weighted reform agenda.

Roadmap for a WASA Managing Director

Apart from the actions recommended earlier, the following road map should also be pursued. A workshop conducted at the Rawalpindi WASA indicated that most of the actions (termed as doable/partially doable) needed to address key challenges could be fully/significantly addressed by the utility itself with little or no investment. For instance (i) monitoring/reading already installed meters does not require any investment, (ii) conducting consumer surveys to detect illegal connections requires very little investment (the Rawalpindi WASA spent PR2 million and identified thousands of illegal connections and recovered the amount in few months), and (iii) conducting energy audits as the first step in retrofitting pumping machinery and to curtailing energy costs is also not expensive. In other words, prior to substantial investments a lot of homework is needed that requires only leadership with vision, motivation, and the right direction. Table A5.10 lists challenges and potential solutions for WASA managers.

Peshawar

Peshawar is the provincial capital of Khyber Pakhtunkhwa province with an estimated population of 1.7 to 2 million; it is a fast growing city. Peshawar relies entirely on groundwater for its potable water supply. Production and distribution activities are split among seven different entities (towns I to IV, the provincial development authority, PHED, cantonment board) that oversee 820 tube wells and 4,700 employees (a record ratio of 59 employees per 1000 water connections). This complicated organization does not yield reliable statistics or make sound decisions.

The provincial government has shown an interest in institutional water reform and has appointed a committee to make proposals for a more productive and efficient organization. There is a proposal to create a single WASA by merging all entities except the cantonment board to manage water from production to sanitation as well as solid waste collection and disposal. It would be an autonomous body adopting corporate governance methods under the strategic guidance of a board of directors comprising representatives from the government, customers associations, private/civic institutions, professionals, and the chief operating officer of the utility. We recommend that this change be implemented as soon as possible. The WSP and USAID are already supporting this process.

Quetta

The city of Quetta relies entirely on the groundwater table for its potable water supply. Three service providers produce and distribute water: WASA (70% of the population), PHED (25% of the population on the outskirts of the city), and the cantonment board (5% of the population). There are unofficial water suppliers from private tube wells. Population estimates vary from 1 to 2 million inhabitants.

Production per capita per day is assumed to be about 20 gallons before taking into account physical losses. A federally funded project for PRs7 billion increased production in 2000, but physical losses and NRW remain high. WASA manages 70,000 water connections; its repre-

Table A5.10: Challenges and Solutions for Managers

Challenge	Solutions
	Increase revenues by:
Balanced operating accounts	<ul style="list-style-type: none"> • Incorporating illegal consumers (number of bills can be increased by 10% to 35% depending on the city); staff knows most of them • Customer survey (update customer database, find illegals, systematic control of accuracy and completeness of billing data) • Improve money collection (incentives for collectors, reminders, service cuts) • Index water tariffs to electricity cost (35% to 55% of operating costs) (managers have no power to implement)
Customer satisfaction	<ul style="list-style-type: none"> • Allow customers to complain: professional attention desks, call centers, record and classify complaints • Group the complaints, act to solve them • Show a good example: set up an organization to repair all visible leaks rapidly • Launch simple awareness campaigns for water waste reduction (media, educational material for teachers)
Water quality	<ul style="list-style-type: none"> • Ensure maximum quality by systematic chlorination of production points (all filtration plants and all tube wells)
Water quantity	<ul style="list-style-type: none"> • Ensure that all production facilities are in order and working at maximum capacity • Install bulk water meters on all production points and all bulk delivery points (you manage what you can measure) • Check all reservoir overflows
Staff management	<ul style="list-style-type: none"> • Set up a limited number of key objectives for the entire utility (to be followed regularly in a shared board table) • Management by merit • Develop spirit of dedication to clients • A few key skilled professionals might be hired from the private sector

Source: WSTF Urban Team compilation using WASA data and information gathered from interviews and site visits

sentatives assume that at least an equal number of illegal connections exist. The collection rate is very low, and the last tariff increase dates from 1992. The last customer survey was in 1994.

Quetta is on a totally unsustainable track. The water table is depleting by 6 to 7 feet a year, and population growth is one of the highest in the country due to migrants from Afghanistan. As mentioned previously, in the recent years there has been a lack of political will to tackle the sensitive issue of overexploitation of the aquifer by irrigation tube wells. Despite technical reports and recommendations, no real step forward has been taken and water table recharge remains around half of the current abstraction. Considering that it is impossible to close down all irrigation tube wells in the short term, we propose a combination of survival measures in Table A5.6.

A special local task force should be set up under the authority of the chief minister to lead negotiations with farmers and coordinate actions among the various departments concerned. A rough estimate for compensating farmers and for specific recharge works amounts to PRs3.5 billion. Several donors have already funded studies on this issue; if political will is clear, we assume they would further assist to pull Balochistan’s capital city out of its current alarming downward spiral.

Lahore

Lahore's draft Water and Sanitation Master Plan funded by JICA is a good assessment of the current and future challenges of this city of 6 to 7 million inhabitants. The water supply is provided by 460 tube wells run by the Lahore WASA that pumps an average of 1.6 million cubic meters a day. Due to the fairly good service provided, few private tube wells have been bored except those for industrial use; nevertheless, thousands of irrigation tube wells in the environs are tapping the same aquifer. The water table is around 100 feet deep; it is depleting by 2 to 3 feet a year. The recharge is powerful with a gradient from northeast to southwest.

There are some local fears of a possible saline intrusion from the south, but according to available data, hydro-geologists do not consider this issue to be a particular risk. Per capita production amounts to around 64 gallons/day which is very high and gives an average daily per capita consumption of 50 gallons or 230 litres considering 20% physical loss. This consumption is far above international standards as confirmed in the breakdown of the current consumption (and tariff) of the 16% of consumers equipped with a water meter in Table A5.11.

Table A5.11: Average Metered Domestic Tariff in Lahore

Sr. No.	Domestic Consumption Range (Gallons/month)	Tariff (PRs per 1000 Gallons)	% of Connections	Weighted Tariff
1	Up to 5000	12.88	20	2.576
2	5001 to 20,000	20.86	69	14.393
3	20,001 or more	27.30	11	3.003
Average Metered Tariff (PRs per 1000 gallons)			100	19.9724

Source: WSTF

If we consider an average monthly consumption of 10,000 gallons per household of 7 persons, the daily average consumption per capita corresponds to the above estimate of 50 gallons per capita. The sewerage charge amounts to 70% of the water charge. According to our estimate, the monthly bill for an average household is similar whether consumption is metered or not; it amounts to PRs150–200, i.e., around 1% of the average household income. The last tariff increase was in 2004; the general context is characterized by low tariffs and high waste by customers.

Industrial consumption is not controlled and is not billed as the companies pump from their tube wells; a sewerage charge is billed to industries but as no consumption is measured, it may not correspond to reality. Alternatives for supplying surface water in the future to Lahore exist: the three main options are intakes on the Bambanwala-Ravi-Bedian-Diplpur Canal, the Lahore Branch, and the Ravi River; this would require water rights permission from the irrigation department; it would also require strong investments to build the intake, the filtration plant, and the water network.

The existing distribution network is made up of 25 separate units, each fed by several tube wells.

The option of reinforcing the water supply by surface water would require a completely new network of feeders and reservoirs as the existing transport capacity is limited. The team does not recommend seeking an additional supply of surface water. As NRW can be estimated at 35% to 40%, a great deal of improvement can be made by reducing in leaks, integrating illegal connections (estimated at of 10% new customers), and establishing appropriate tariffs and volume measurements.

A few new tube wells will have to be drilled in the future to face demographic growth and to avoid overexploiting the water table. We recommend that they be installed near the Ravi River and canals where the table is much higher and possibly on the opposite side of these water bodies.

As far as water services are concerned, there are positive impacts from appointing a WASA manager on a competitive basis as well as from the benchmarking efforts made between the Punjab WASAs with support from the WSP. Due to the network architecture, it is easier than elsewhere to reduce contamination by running a reduced number of tube wells during the night to maintain a minimum pressure. The collection rate for bills is around 80%, a result of the efforts and of the incentives paid to the collection staff. Efforts have also been made to improve customer care.

Less positive points that require urgent action are that more than 200 bulk meters should be installed on the tube wells to begin properly managing NRW as only 10% are in working order. In addition, 68% of the tube wells are equipped with chlorinators but only half of them are disinfecting properly. This is a public health priority and can be solved easily with a small investment in operation costs.

As mentioned in Table A5.9, the operations and maintenance financial deficit amounts to PRs1.7 billion. The master plan consultants calculated that if nothing is done, this deficit will increase by an estimated PRs500 million a year.

Regarding sanitation, there is no treatment of effluents from Lahore's five urban watersheds; they are screened and pumped into the natural water bodies, mainly the Ravi River. Six sites for future waste water treatment plants have been identified all around the city. In the next 10 years, the draft master plan recommends beginning with the major site in the southwest to collect effluent from central Lahore (nearly 4 million people and industries for a total discharge of 900,000 cubic meters/day). In the following decade, phase 2 will focus on the south, the most rapidly growing part of the city. In addition, a financial agreement for a project with French assistance has been signed to build the northern plant in the Mehmood Booti area serving 1.4 million people and several industries though no final decision has been made on this project to date.

In our discussions with local professionals, we learned that the plants are not their current first priority except possibly the one in the southwest. If funds were available, they would instead extend and refurbish the collector network, mainly in the fast growing southern part of the city at an estimated cost of PRs18 billion in several phases.

Given the current deficit, large, new investments and their related operating costs seem unrealistic before appropriate reforms and tariff policies are settled and before "the house is put in order." Nevertheless, there was consensus to begin effectively controlling the most contaminating industries and activities in Lahore District. By law this control is the responsibility of the EPA's Environment Department, but it is not enforced. We recommend that this begin with the full support of the provincial government. The most important industries to investigate are in the northern boundaries of Lahore (800 steel producing units), between the city and the Ravi River (about 219 mixed industries), and in the Hudirara drain area where about 300 textile producers are discharging. The Dutch-assisted projects on the Quaid-e-Azam Industrial Estate (379 units with 6 pre-treatment facilities) and PISD II (Sundar Industrial Estate Raiwind) offer interesting lessons.

Another recommended step is to install water meters on all industrial tube wells. In addition to measuring ground water abstraction, the meters will allow WASA to bill for sewerage on a fair basis and will certainly create an incentive for water users to reduce their consumption and to recycle part of it.

Karachi

Karachi is a federation of 18 cities that relies almost exclusively on surface water supply. The population is estimated to be between 18 and 20 million. JICA funded a water master plan that was revised in 2008. Since then, no major work has been done. Daily water production is 650 million gallons only 2 million of which are produced from the ancient Dumlottee wells. All the rest comes from surface water. Only 14% of the surface water comes from the Hub Dam located 50 km to the northwest on the Hub River. The remaining 86% comes from the Indus system (Kinjhar Lake located at 170 km from Karachi). The water is conveyed through a canal then pumped into feeders at the Dhabeji station. Of the 650 million gallons, 68% is treated in filtration plants; the rest is only chlorinated and pumped into the network.

Water production per capita is roughly 35 gallons per day, but the yearly population growth is estimated at 4%. In the future, the only realistic additional supply for Karachi will come from the Indus system. The last investment in the system (KIII) was completed in 2006 and increased the capacity of Dhabeji pumping station. There is a KIV project to further increase the water supply by building a new feeder canal and a new pumping station. The first phase of KIV would provide an additional 260 million gallons/day at an estimated cost of PRs30 billion.

The KW&SB is responsible for all water management from production to sanitation. The quality of service is very poor. Water is rationed erratically and is available approximately 5 hours a day. The filtration plants are well maintained. Water is pumped into the network after chlorination; laboratory facilities exist and perform fairly well. Nevertheless, there is contamination in the network as a result of leaks, depressurization, and the use of sucking pumps by customers.

The KW&SB delivers water in bulk through a meter to the cantonment board that serves 10% of the population and to industrial complexes. Retail deliveries are not metered, and the tariff is low at PRs60/month. Despite the repeated demands of WASA managers, no tariff increase has been allowed for 9 years.

The total collection rate is between 60% and 65%. We estimated that around 35% of water users do not receive a bill by comparing the number of water bills and the number of electricity bills (1.9 million) taking into account the customers served by the cantonment board and DHA and the fact that electricity is billed by apartment in residential buildings (this is rarely the case for water). There is a lot to be done to bill users in the poor residential areas and to incorporate illegal users into the billing system. Currently, NRW is at least 40%; taking the collection rate into account, roughly 60% of the water produced is not paid for.

Overstaffing is tremendous; in 2006 KS&WB had to accept 6000 additional employees due to political influence. Although there are offices in all 18 municipalities, the existing organization does not allow the improvement of the quality and efficiency of the service. The following table summarizes the operations and maintenance balance in 2010/2011.

It should be noted that only a very limited part of the electricity bill is actually paid to Karachi Electric Supply Corporation. The managers have requested an additional PR\$3 billion to run the service properly.

Regarding sanitation, the first two waste water treatment plants were constructed in the 1960s. One has been abandoned and occupied by squatters; the second (Haroronabad) had an initial capacity of 51 million gallons/day but frequently breaks down; in fact, it had been out of operation for 3 days due to a problem with an electrical cable when we visited. Due to poor maintenance and repair, only two of the eight trickling filters are working. The Maripu plant was built in 1998 with a capacity of 54 million gallons/day. It has 6 anaerobic ponds and 6 facultative stabilization ponds, and the treatment parameters are correct and meet NEQS standards. This process keeps maintenance costs low but requires a lot of land (545 acres).

Less than 10% of effluents are currently treated; most of the contamination is transported to the sea in the Malir and Lyari rivers. Project SIII was to be launched to provide an additional 500 million gallons/day treatment capacity by rehabilitating existing plants and constructing a new one and to detach all sewage flows from drainage system (interceptors). The cost is \$1 billion to be shared by the federal and provincial governments and the Karachi Port Trust. This project has been staffed but it has not started due to a lack of funding.

Sanitation is a huge challenge in Karachi as is solid waste management (a large part of it is currently dumped into the rivers). As the main industrial city in Pakistan, Karachi puts a great deal of stress on the environment as discharge is not controlled so untreated contaminants are released into natural water bodies. We strongly recommend that priority is given to identifying and controlling the most dangerous polluters (hospitals, industries) as they will solve the problem if they have more knowledge of the risks their actions pose, if the laws are enforced, and if public opinion puts pressure on them. Multinational companies in particular pay a lot of attention to public perceptions about them. Positive steps have been taken by 170 to 180 tanneries that are collecting their waste water and treating it in the Tannery Cluster treatment plant. Since 1982, Pakistan Steel Mills have operated their own treatment plant for industrial waste together with the domestic sewage from their company housing compounds (about 4500 cubic meters/day). The effluent is pumped to the Pakistan Air Force premises nearby for watering plants. The costs of the installations and pumping for the effluent are borne by the air force. The treated effluent is also used by a nearby golf course and an orchard.

As in all Pakistani cities, the first step before investing in large structural projects and their subsequent costs is to do the homework and to evolve into a sustainable, customer-friendly organization. Given the size of the city and the current state of KW&SB, this is a huge challenge in Karachi. We agree with the recommendations of the JICA master plan as summarized below.

- Bulk and retail supplies should be separated.
- Bulk supply should be operated by KW&SB.

Table A5:12: Budget Summary of Karachi Water and Sewerage Board in 2010/2011 (Pakistani rupees [billions])

Revenue	5.3
Expenditures	8.5
Manpower costs	2.8
Operation costs	1.3
Electricity costs	4.4
Ratio electricity costs/total costs	52%
Balance	-2.7

- Retail services (water and sanitation) should be transferred from KW&SB to new private limited companies on a zone-by-zone basis.
- The first should be the western zone, and within this zone a group of three municipalities (north Nazimabad, Guldberg, and Liaquatabad) would be a pilot area for refurbishing important infrastructure, domestic metering, reducing NRW, and improving customer service.
- An independent regulatory board should be created for the economic and technical regulation of services.

General Recommendations

1. Institutional reforms are needed to give autonomy to the water utilities, but we can understand that political leaders cannot prioritize everything and that the feasibility of this differs from one province to the other. As a consequence, the recommendations take into account the level of political willingness in each province for institutional reforms.
2. Where there is no particular willingness, business as usual will continue; the road map for WASA managers in Part C section 2a can be applied and can deliver some improvements. These improvements will require operational capital expenditures in reasonable amounts that will have to be provided by the province as the utility is not self-sufficient.
3. In the provinces and cities where there is political will to reverse the situation, the first step will be to improve customer satisfaction and to balance the operation and maintenance accounts. In our opinion, this goal can be achieved in 2 to 6 years taking into account the original situation and the intensity of remedial measures (cases like Peshawar or Quetta will take longer).

Which Water Management Model?

One very positive point we noted is that there is strong agreement between donors and operating managers that to attract external financing—particularly for future additional surface water supplies and network extension and rehabilitation—service providers have first to put their own houses in order. This requires placing confidence in the managers in charge and eliminating daily political interference in the utilities. Provincial and the local governments have to focus on the strategic choices to be made and on the implementation of the needed provincial reforms.

This annex does not aim to describe existing management models worldwide. Given the existing constraints of the country (security and finances), we think that international private participation in water management is not the most realistic option, but in some cities where these constraints are less critical (Lahore, other smaller Punjabi cities), some interest could be shown by international service companies, possibly from emerging countries.

In the past decade, various private management success stories have been recorded in Africa and Asia under different contractual models; implementing private management contracts can speed up customer care and financial recovery in the main Punjabi cities. This would require a determined choice by the provincial authorities and adequate autonomy for the appointed operator. As far as we know, there is no Pakistani experience with private management of water utilities; nevertheless, private companies are clearly needed in every city. Earlier efforts include the following:

The proposed ADB-funded Punjab Cities Improvement Investment Program. The goal was to improve water, sanitation, and solid waste services in six medium-sized cities in Punjab beginning with Sialkot. The first phase cost \$100 million; further infrastructure investments

in several tranches at a cost of \$2.35 billion are planned for the next 20 years. This project is based on a performance contract to be set up with an international private operator implemented by three government-owned water and sanitation companies though there appears to be some reluctance among local decision makers to adopt this privately operated system.

The ADB-funded Sindh Cities Improvement Project. This covers Sukkur City and a cluster of medium-sized neighboring cities. An autonomous company owned by the Sindh government called North Sindh Urban Services Company was launched in 2009. The company manager was appointed under a competitive process, and the first stage of funding amounts roughly \$25 million for infrastructure rehabilitation and solid waste equipment. This project has proceeded with difficulties as local political influence has been very strong; in fact, the managing director resigned after 1 year and has not been replaced as yet.

After summarizing all our interviews and documentation and reviewing existing projects, our opinion is that the key water reform to make where there is political will is to create a provincial regulatory body. The main features and a road map for the regulatory body are described in Table A5.13.

An interesting step forward in Punjab is that a special committee is drafting the Punjab Municipal Water Act to set up a provincial regulator. The only observation we can make about this future regulator is that the province should avoid creating a heavy bureaucracy. For instance, provincial water appropriation permits and related suspensions and fines should preferably be done at the level of existing local governments under provincial guide lines. To be efficient and productive, the regulator should concentrate on the key responsibilities described in Table A5.13.

A Public, Performance-Based Management Contract

As mentioned before, our opinion is that the market for classic private management contracts will be limited in the coming years. Under the existing complicated economic circumstances of the country, there are a few success stories of reliance on local autonomous companies without inputs from a private partner. Examples are domestic gas service providers and more recently the new solid waste service provider in Lahore. For water services, our opinion is that the prerequisites for a successful autonomous public water company are two:

- political will from the chief minister to give genuine autonomy and to have confidence in the utility management team; and
- clear will from a group of 5 to 10 managers under the existing (or to be appointed) leader to apply the road map described in Part C Section 2a.

Table A5.13: Features of a Provincial Regulatory Body

Q: Why a regulatory body?

- A: To manage provincial water issues with a long-term view without short-term political turbulence
- Should be launched after first management contract is created (see Part D Section 2)

Q: Head commission composition

- A: Suggestions:
- A few professionals (technical, financial)
 - Representatives of civil society/customers' associations
 - Government representatives
 - One appointed executive director

Q: Main responsibilities

- A: To protect customers rights and interests
- To set reasonable water tariffs
 - To monitor the performance of the water utilities

Q: Who pays for it?

- A: In principle a regulator receives a small percentage of the water revenue
- At present it has to be funded by the provincial government

The principle is to set up a performance-based management contract between the provincial government and the group of local leaders. This contract would accompany the transformation of the local utility into an autonomous company and the launching of the regulatory body. The most similar model is the management system in Kampala, Uganda, but each management contract in Pakistan should adopt a fixed framework but be tailor made according to the initial assessment of the service situation (Table A5.14).

Table A5.14: Main Features of a Management Contract

Components of the contract	Description
Assessment of the starting point	<ul style="list-style-type: none"> List of committed managing partners Fair description of the existing situation Definition of the key indicators to be followed Starting value of these indicators Contract duration 3 to 6 years
A clear contractual road map	<ul style="list-style-type: none"> Describe power given to the managing team, e.g., hire and fire, incentives to staff, choice of priority operating investments Indicators contractually followed (maximum five to seven) Incentives linked to achievements (target values, timing to reach targets) Initial tariff and evolution rules Contract has to be negotiated with the managers to make it realistic, ambitious, and achievable
Yearly financial incentives to the managers	<ul style="list-style-type: none"> Transparent amount and distribution among managers according to their position Easy to calculate, very few indicators Indicative bonus range: 25% to 100% of annual wage

Components of the contract	Description
Examples of targets	<p>A mix of indicators of means and results:</p> <ul style="list-style-type: none"> • Balanced accounts with intermediate steps • Number of billed clients • Collection rate • Number of bulk meters to be installed • Number of working chlorinators • New operational customer system • Call center and statistics
Need for operational capital expenses	<p>Examples :</p> <ul style="list-style-type: none"> • Create/refurbish client attention offices and desks • Customer survey • New customer system • Submersible pumps • Spare parts • Computers • Vehicles
Need for operational capital expenses	<ul style="list-style-type: none"> • Bulk meters • Chlorinators • Renewal of damaged mains • Repair of broken collectors • Focused consultancy
Yearly independent assessment of progresses	<ul style="list-style-type: none"> • Appointment of a special consultant by the regulator • Yearly report with direct consequences on the financial bonus
Possible role of donors	<ul style="list-style-type: none"> • International experience of management contracts (particularly the ADB and World Bank) • Provide consultants • Funding of required capital expenses • Training of staff, all levels

Situation Analysis

Context

In spite of the importance of water in Pakistan's economy and politics, water management in Pakistan has not kept pace with that in the rest of the world. There is limited debate on water management options in addition to missing links between research, education, and the operations of water agencies. Basic water data collection is limited, in some cases suspended, and in other cases marginalized. Pakistan's water systems are complex and face vexing challenges such as the following.

- **Keeping up with population growth:** The rampant population growth in Pakistan will cause severe water shortages which will be aggravated for future generations. It is estimated that Pakistan will be a water scarcity country in the near future.
- **Climate change:** In 2010 and 2011, the most devastating and record breaking flood events in the history of Pakistan occurred. Prognostications are that these sorts of events are likely to be repeated more frequently and cause even more severe problems. Additionally, it is highly probable that due to climate change, the annual monsoon season will become more unpredictable.
- **Water storage:** Pakistan is in desperate need of additional water storage to guarantee sufficient supply to the agricultural sector as well as to help prevent floods. Obtaining it involves a complex series of tasks that requires input from major infrastructure development and water resource management specialists as well as significant financial resources. There has been no increase in surface water storage since 1976 after Tarbela Dam was built.
- **Intensive groundwater pumping:** The spontaneous growth in the number of tube wells has changed the water balance resulting in overexploitation and the deterioration of groundwater quality in certain areas. In other areas waterlogging persists. There is as yet little expertise in Pakistan to manage groundwater as a precious resource or as a menace due to the waterlogging and salinity stresses it causes on irrigated agriculture. The knowledge of recharge techniques is very limited.
- **Increasing frequency of hydro-hazards:** Over the last decade, Pakistan has had more than its fair share of natural catastrophes such as droughts, floods, groundwater problems, landslides, and glacial lake outburst floods (GLOFs) causing large numbers of fatalities and serious damage to or loss of property and belongings. These calamities have been major setbacks to Pakistan's economy especially in the rural areas where the majority of the population is poor and lacks services.

Pakistan's water systems are run with conventional engineering knowledge and need an injection of modern interdisciplinary expertise including the following:

- Multidisciplinary water law and policy education linked with the Indus Water Treaty and the Water Accord should be taught so future generations understand and deal with international court cases on trans-boundary water and provincial conflicts on water distribution and hydro-politics at all levels.
- Forecasting inflows for water allocation and distribution is based on limited knowledge of climate science due to a separation between water management and meteorological skills.
- The fair distribution of allocated water is still a great issue among the provinces.
- There is no river water accounting system with reliable estimates of losses between the river reaches or by irrigation canal commands.
- Though 40% of the land is waterlogged in Sindh, data collection and reporting on shallow groundwater levels and soil salinity are inadequate or have been suspended.
- Most of the Balochistan Irrigation Department's water resource data was lost in riots. Information is now available from consultants at best.
- There has been a continued brain drain due to a lack of incentives and appropriate career paths which has implications for both the public and the private sector.
- International water research activities and links in Pakistan are on the decline. The relevance, quality, and utility of local research is continuously questioned by the operating agencies.
- The expansion of irrigation systems related to population growth has put more stress on the already stretched water managers. The number of professional irrigation engineers per 1000 hectares of command area in Pakistan is grossly inadequate. It is one-fifth of what it is in Egypt where there is an irrigation system quite comparable to that of Pakistan (in fact the Egyptian system is easier to operate).

If any of the action areas highlighted by the Water Sector Task Force (WSTF) is to bear fruit, it has to be sustained by a different culture for managing water and the operation of water facilities. Services should be managed on the basis of measured performance and by using knowledge of engineering, water law, the environment, economics, and other relevant disciplines. Educational curricula should be overhauled to create a pragmatic integrated look at water resources in a trans-boundary national and international context. University education needs to be linked through internships to the real world nourishing both scientific knowledge and industry needs.

A young, eager generation of water managers able to compete in the private sector and responsive to the public sector needs to be groomed. Modern, information technology (IT) should be part of the operation of the water system—for example using mobile phones to respond to emergencies, to report on breakdowns of drinking water facilities and to make electronic payments. Reliable information should be available to all water users, be they managers of water

and sanitation authorities (WASAs), a farmers' organization in Punjab or Sindh, or farmers operating tube wells in Balochistan.

Need for Right Water Knowledge

Access to water information and knowledge networking are key factors in effective water resource management. The major problem in Pakistan does not stem solely from a shortage of resources. The water sector is affected by insufficiently trained experts and a lack of links between the public and private sectors causing a serious threat to water resources as well as serious environmental degradation.

Unfortunately, as in other developing countries, the information available on the Internet and outside of it about water in Pakistan is quite limited and for the most part out of date. Lately, with the emergence of IT at the forefront of the national agenda and the announcement of IT policies by the federal government recognizing the “convergence of core technologies and e-governance,” the creation of such networks nationally will not only help sector users and professionals but will also facilitate building up the IT infrastructure in different sectors in the country.

Understanding the Role of Groundwater in Water Management

As outlined in detail in the Main Report and Annex 3, improved operation-oriented knowledge on groundwater is of the highest priority.

Existing Capacity Building Efforts through Higher Education

The Higher Education Commission (HEC) has existed in Pakistan since 2002.¹ It describes its role as, “Facilitating institutions of higher learning to serve as engines of growth for the socio-economic aspects of Pakistan.” To achieve its human development goals and to facilitate transition to a knowledge economy, the HEC adopted a strategy to create an enabling environment for quality education in all institutions of higher learning through faculty and infrastructure development; by supporting the faculty and students in teaching and research; and by bringing equity, quality, transparency, and efficiency to the operations of the institutions.² The budget for the Medium-Term Development Framework for Higher Education (2011–2015) is approximately \$4.0 billion over the next 5 years.

This has been an important step in improving the higher education system in Pakistan to satisfy the professional needs of government authorities and private entities for highly qualified water engineers and for the general public to access higher standards of education. Pakistan currently still has very few resources in the higher education sector as only 7.8% of the 17–23 age groups have access to higher education, and universities award only 700 PhD degrees each year (footnote 2, page 3).

Problems in the Tertiary Education Sector

Despite HEC efforts, the higher education sector in Pakistan still has several problems including the following:

- lack of national and local ownership of higher education;
- poor university-industry interaction;
- poor university-community relationships;
- low quality and lack of employability of college and private graduates;

1. *The Government of Pakistan, Higher Education Commission. www.hec.gov.pk*

2. *HEC Medium Term Development Framework (2011-2015). p.8. <http://hec.gov.pk/InsideHEC/Pages/InHEC2.aspx>*

- lack of appropriately qualified, high-quality research faculty for universities;
- lack of capacity for continuous faculty and staff development;
- low enrollment in the tertiary education sector;
- poor governance at universities;
- lack of financial support for students who need it through student loans or other grants;
- insufficient funding for research and insufficient user charge recovery by universities (footnote 2, page 17).

Broader Water Education Issues

It is fair to say that water management is not mainstreamed in decision making, and even in education there is a preference for civil engineering rather than for multidisciplinary approaches to water management and the integrated solutions and management systems that come with it. Obviously this needs to change from the current generation of water managers to the cohort of young professionals that is coming up. This will require the following inputs:

- short-term, mid-career training based on practical cases, e.g., training and research in managing local river basins;
- easily understood products like maps and data sheets in local languages to serve a wide range of non-technical water managers and training for them and farmers' organizations and local communities; and
- better connections between secondary schools, universities, and water organizations to gain familiarity with existing data, models, and standard operating procedures and to introduce real-life learning of the importance of water security in Pakistan.

There is a need to encourage water education at all levels. This may be facilitated through distance learning using modern IT.

Institutional Needs

In Pakistan, various organizations are in charge of different aspects of water management. As part of the Water Sector Capacity Building and Advisory Services Projects (WCAP), a capacity needs assessment of these organizations was done, and the recommendation was to strengthen the technical capacity of the water section of the planning commission of the Indus River System Authority (IRSA) and of the Federal Flood Commission (FFC). The payment and benefit structures of the organizations need to be improved to attract and retain high caliber staff. This should be combined with local and foreign training possibilities and the establishment of senior engineer posts to offer careers within these institutions. There is also a need for capacity building for farmers and private users and for the field staff of implementing agencies.

Current State of the Decision Support Systems

Covering over 1,165,000 square kilometers (km) the Indus River is one of the largest and the most complex in the world. Consisting of the main Indus, two western tributaries, and five eastern tributaries, this river system is shared by Afghanistan, the People's Republic of China (PRC), India, and Pakistan. The rugged terrain surrounding the river in Afghanistan and the PRC has thus far prohibited or minimized their ability to develop the river basin within their borders. As a result, only India and Pakistan are dependent on it, and they have developed it extensively. In Pakistan, the Indus River is the primary source of water that brings to life its otherwise arid land. In India, the waters provide the economic foundation for its relatively arid northwestern provinces which have become the country's bread basket.

The Indus Basin system is currently managed based on the existing inter-provincial Water Accord of 1991. A number of separate standard operating rules and guidelines exist for managing storage, for consuming water supply (agricultural, urban, and industrial), for generating hydroelectric power, for managing floods and drought and for environmental water releases by both federal and provincial agencies; however, no comprehensive multi-functional decision support models or asset management systems currently exist.

Water Management

The Indus Basin Model is the only whole-of-the-river-basin planning model in Pakistan, but it has limited visualization and decision support capability. The primary purpose was to evaluate investment scenarios for new water-storage projects; it is not capable of providing any assistance with the day-to-day operations. IRSAs current spreadsheet for forecasting water allocations utilizes last winter's flows to predict summer water availability and the reverse for predicting winter water availability. The model is currently being updated, but it will still fall well short of becoming operational. No models or decision support systems exist for operating the irrigation canal network or managing on-farm water supply though MODLFOW-based groundwater models exist for some aquifer systems.

The decision support systems for flood forecasting are unreliable and are therefore in urgent need of upgrading using the latest remote sensing technologies. These systems also do not cater for the flash flood forecasts with the limited lead times available in Khyber Pakhtunkhwa and Baluchistan.

Asset Management

The Punjab Irrigation Department developed an asset management plan in 2005 as part of the Punjab Irrigation Sector Reform Programme supported by the World Bank. Implementation commenced in 2006 and was completed in 2007 with the preparation of an inventory and budget. The primary objective was identifying costs and seeking funds for maintenance, replacement, rehabilitation and upgrading works from 2007 to 2017. After the initial exercise, it appears that no further efforts were made to maintain the database or to keep it up to date.

All other provinces have asset management systems in place for capital works programs and operation/maintenance costs. They are primarily used by managers to work out budgets and funding.

Australian Example

A relevant example of a modern approach to developing decision support systems is that of the e-Water Cooperative Research Centre in Australia. This program was motivated by the observation that there were many different decision support systems serving different purposes, and that while each system had an internal logic and value, the definitions, structure and outputs of the models were such that the models could not be integrated. The whole was much less than the sum of the parts. The e-Water approach was to start with an architecture which would define parameters and models for all purposes at all levels in a way that the resulting suite of models (a) would meet the immediate needs of specific decision makers (b) use consistent definitions and data and (c) be capable of adapting as data, understanding and challenges developed. The e-Water Cooperative Research Centre Toolkit is the result: it provides a convenient one-stop shop for water and catchment management utility tools backed by a community of practice. Most of the tools are available as freeware. Now with more than 10,000 users in over 120 countries, the toolkit is a web-based distribution point for hydrological, ecological, and catchment

management models, databases, and other resources useful to all involved in land and water management or related areas.

There is an immediate need for improving the flood and drought forecasting and warning system in Pakistan by developing a comprehensive, state-of-the-art decision support system for assessing river and groundwater availability and management, irrigation infrastructure operations, and flood and drought management. There is also a need to set up an institutional and technically skilled platform such as a center of excellence in integrated water resource management affiliated with the university system. Such a center would be able to adapt technologies to specific conditions in Pakistan.

Climate Change Impacts on Water Resources

Climate change is considered to be a critical factor in changing rainfall patterns and the visible increase in precipitation during monsoon seasons in parts of the country. There remain very large uncertainties in the impacts of climate change, not least with respect to the behavior of Himalayan glaciers and monsoon rainfall. That said research based on long-term climate change data points toward future occurrences of heavy rainfall events during monsoon seasons over the northwest instead of the northeast. As a result, areas along the western rivers of the country (Indus and Kabul) are likely to be more vulnerable to flooding similar to the recent ones experienced. There is a need to strengthen national technical capacity to deal with uncertainty and risk in general, and climate change in particular, and to increase support for national climate change research centers which focus on understanding the consequences for managers of the water systems of Pakistan.

The effects of climate change on glaciers and on river flows in the western part of the country are not yet clear, and there are still major uncertainties about the size of the glaciated areas in the Indus catchment area. (For example, a recent article in *Nature*³ estimated that high mountains of Asia show a mass loss of only $4 \pm 20 \text{ Gt yr}^{-1}$ for 2003–2010, compared with 47–55 Gt yr^{-1} in previously published estimates.)

The Water and Power Development Authority (WAPDA) and ICIMOD are planning an ambitious joint program on mass balance studies with snout observations at 50 glaciers and mass balances on five. Climate stations will also be set up at high elevations; two have already been started in the Hunza River basin (Barpu and Passu glaciers). Measurements of ice thicknesses are also essential but are lacking. ICIMOD plans to buy a new type of glacier radar and to use it on selected glaciers. Today the estimate of the total ice volume of existing glaciers is based on measurements in other parts of the world; the average is somewhere between 100 and 200 meters of ice. Using these figures gives an estimate of 2250–4500 cubic km of glacial ice or 2000–4000 billion cubic meters of water stored in Pakistani glaciers today.⁴

In the same article, Immerzeel et al. presented calculations of the future discharge in the Upper Indus basin based on a well-tested hydrological runoff model using input values from remote sensing and climate change scenarios. One of the findings was that the future development of the glacial area and volume is of very high importance for the output results from the model.

3. Jonathan Bamber “Climate change: Shrinking glaciers under scrutiny”, and T. Jacob, J. Wahr, T. Pfeffer and S. Swendsen, “Recent contributions of glaciers and ice caps to sea level rise” *Nature*, 8 Feb 2012.

4. W.W. Immerzeel et al, 2009: Large-scale monitoring of snow and areal runoff simulation in Himalayan river basins using remote sensing. *Journal of Remote Sensing in Environment* 113 (2009).

If the glaciers totally disappear, the average summer maximum flow to Tarbela Reservoir will drop to 4000 cubic meters/second compared with an average maximum discharge of 7500 cubic meters/second if the glaciers are unchanged.

The total water inflow to the Indus catchment area is on the order of 187 billion cubic meters per year (Pakistan Water Sector Strategy. 2002. vol. 5). So, the extra glacial water inflows are on the order of 4%–8% of the total inflow volume today. This number, which should be considered as being rather conservative, will be significantly higher for the parts of the rivers with the highest glacial areas. It should be stressed, however, that the glacial ice volumes cannot last forever. With an average annual melt rate of around 750 millimeters/glacier area unit, most of the ice will be gone in 100 years. This value is in accordance with the values used by Immerzeel et al.

The following actions are needed:

- Mapping all existing glaciers in the Indus catchment area should be given high priority by ICIMOD.
- Mass balance measurements should be done on more glaciers by WAPDA and ICIMOD.
- WAPDA and ICIMOD should measure ice thickness and calculate the ice volume of all the glaciers
- WAPDA and ICIMOD should calculate glacial melt water volumes in greater detail both in space and time when the data from 1–4 are improved.
- WAPDA should transfer results from the climate change hydrographs to hydropower planners.

Despite all flood control measures, there will always be a risk that a disaster might happen. In order to deal with this risk, there is a need to develop the capacity, methodology, and institutional systems to make multi-hazard risk assessments and damage and needs assessments. National technical capacity should be strengthened within a framework of developing integrated (interdisciplinary) approaches to flood risk management that includes training courses for government officials and nongovernment organizations (NGOs) on flood risk management, adopting state-of-the-art technology, producing technical experts, strengthening education, and establishing partnerships with international universities and institutions.

Priorities for Action

The prime objective in each area is to engage a large number of water operators and system managers and to develop an eager cadre with new talent, at all levels. This will be reflected in the way the proposed activities are organized (engaging the young, making use of new IT and media), the organization in which they are rooted (can be private sector as well), and the engagement of water sector organizations (on a personal basis tapping people's creativity and ambitions rather than relying on the dead settings of workshops only).

Develop a River Simulation Model (\$20 million; responsible agencies IRSA and WAPDA)

An Indus River simulation model (or a computer-aided river management system) can help manage water resources in a more effective and efficient manner by relating changes in climate, land use and/or water distribution to the sustainability of water allocation, economic production, and/or ecosystem health. It should be able to capture changes in the volume of water stored in a reference area (e.g., groundwater or a reservoir) or the flow of water and/or constituents at a point in the river network. The time and space scales at which the key processes are understood and can be described need to be appropriately reflected in the model. Such a river simulation model

would use a modular approach to represent surface water, groundwater, urban areas, irrigation systems, and the ecological components of the Indus system. It would be able to accurately estimate catchment rainfall runoff, snow melt flows, river flow processes (i.e. tributary inflows, continuously variable river flow travel times, in-channel storage dynamics, evaporation, evapotranspiration from riparian vegetation, and near-river groundwater exchange) and water storage releases for electricity generation, irrigation, urban, and environmental requirements.

A hydrodynamic river simulation model would provide a range of fully customized decision support user interfaces for river operators by making full use of data from existing and additional flow and water-level monitoring stations, rainfall measurements, and forecasts from the Pakistan Meteorology Department (PMD), river flows and levels as well as real time metering of all diversions. Tributary and snowmelt inflows would be forecast using hydrological models, utilizing both rainfall observations and weather forecasts.

As indicated earlier, The Australian Cooperative Research Centre for e-Water has invested in a modeling platform that makes passing data between models easier and less model-specific (The Invisible Modeling Environment). It makes integrating existing models much easier by allowing different code languages, and negates the overheads of input-output data handling and visualization. The core of the modeling platform is the e-Water Source Integrated Modeling System. Source is a modeling environment containing algorithms and approaches that allow defensible predictions of water flow (and constituents) from catchment sources to river outlets at the sea. It has been designed and developed under the Australian government's collaborative research program to provide a transparent, robust, and replicable approach to underpin a wide range of water planning and management purposes. The model is now in operational use by several state and commonwealth government departments in Australia and is steadily replacing a number of existing models.

Source has been designed specifically for integrated river basin management rather than as a collection of tools for other purposes. It has been developed as a partnership among government agency practitioners, developers, and researchers who will be using the model in their daily operations rather than by external consultants; hence, the model is fit-for-purpose and is not a set of models forced to fit. Source can develop water sharing plans and underpin daily river operations and can assess water quantity and quality due to changes in the following:

- land use and climate;
- demands (irrigation, urban, ecological) ;
- infrastructure types (weirs, storage reservoirs);
- management rules; and
- the impacts of all of the above on various ecological indices.

The model can be configured in either a spatial or schematic layout depending on the requirements of the Indus Basin. The spatial layout is generally used for assessing attributes such as land-use change or variations in regional climate whereas the schematic layout is generally used when assessing larger scale changes to flows in more complex regulated river systems. As long as suitable data are available, the user can switch between viewing modes.

A further important capability is known as a plug-in. This allows the user to define and add a particular algorithm (or process) into the Source model in addition to those currently available. It enables enhanced flexibility for users to customize the Source platform to their unique situations. The model can also be configured down to sub-daily time-steps and is independent

of scale. The platform also contains the ability for the user to insert unique arithmetic expressions that can then be applied to specific situations and time-steps within the model.

Hydrologic and hydrodynamic models will optimize the river system's day-to-day operations by utilizing forecasts of river inflows and real-time water orders coupled with the ability to reproduce the river's behavior. It is also possible to optimize the operation of dam releases and the downstream re-regulation weirs with the objective of meeting all water demands while at the same time minimizing releases from headwater storage.

The higher level of water control possible with the new system will bring positive outcomes for all users—including the environment—along the river including improved service delivery in some parts of the system; more reliable delivery to all water users; greater technology options for irrigators; improved equity for water delivery between users; efficient flood operations to mitigate impacts downstream of the dams; and more confidence in the operation and measurement of the Indus system. River operators will have access to all the information required to make informed and optimal decisions for river operations and for operational planning.

It is proposed that a knowledge base for an Indus River Basin simulation model (or a computer-aided river management system) along with software be developed as a priority action. The investment over a 5-year period is estimated to be \$20 million.

Develop a Decision Support System for Inflow Forecasts and River Operations (\$10 million; responsible agencies PMD, IRSA, and WAPDA)

A real-time decision support system gives accurate forecasts of reservoir inflows, river flows, and floodplain flooding. The estimates of inflow to the dams can be improved by developing artificial intelligence-based sea-surface temperature models that can be linked with synoptic weather patterns and antecedent precipitation and storage conditions in the catchments. There is also a need to develop tools for a synoptic analysis of weather systems to understand climate change impacts on reservoir inflows and to forecast major rainfall patterns in different provinces.

The inflow forecast can be linked with a river decision support system (building on the Indus Basin model knowledge base) for the integrated management of water resources in Pakistan including reservoir operations that would provide a framework and operational plan for structural and non-structural measures to improve agricultural water productivity and water service delivery. This would include developing an adequate knowledge base and analytical tools that would facilitate inter-disciplinary interactions and strategic social, economic, and environmental assessments to assist with integrated water resource management and sustainable planning.

Various modules, decisions, and actions could relate to situations such as basin planning; controlling reservoir releases; regulating canal operations; controlling floods; managing droughts; water quality issues; managing groundwater; recommending agricultural interventions and marketing strategies; and developing new laws, policies, and regulations.

The system would support decisions required at various levels ranging from water users associations to provincial governments and at various time intervals such as 1 day, 1 week, 10 days, 1 month, or longer.

Develop a Canal Management Decision Support System (\$25 million; responsible agencies provincial irrigation and drainage authorities [PIDAs] and provincial irrigation departments [PIDs])

The system will assist canal automation with limited technology and more human interaction. The objectives are the following.

- Investigate a range of options for measuring, monitoring, and controlling water flows and water use to an appropriate standard.
- Improve predictions for demand for irrigation;
- Improve flow management based on real-time flow measurements, forecasting, and control.
- Reduce transmission losses.
- Investigate options for enhancing customer service delivery.
- Improve agricultural production with transparent, equitable water distribution.
- Improve water accounting.
- Sustain the health of the river and the associated ecosystem.

An improvement in canal efficiency would provide more water for everyone including irrigators and the environment by delivering of the correct amount of irrigation water to the right place at the right time with minimal wastage. These improvements could be achieved by investing in technology that provides accurate, real-time measurements of water extractions and canal flows and that accurately forecasts demand. This information will be fed into an appropriate flow and demand forecasting computer model to enable more precise operations. It is anticipated that this decision support system would utilize the knowledge base that is being built as part of the revision of the Indus Basin model.

Develop an Asset Management System (\$10 million; responsible agencies PIDs and PIDAs)

Strategic asset management is the planned alignment of assets to achieve the best possible match with agency service delivery strategies. It is the process of guiding the acquisition, use, and disposal of assets to make the most of their service delivery potential and to manage related risks and costs over their entire lifetime. It requires a strategic framework that establishes the following:

- criteria and standards for the control and management of assets;
- strategies and processes for asset acquisition, maintenance, disposal, and risk management; and
- priorities for allocating resources for asset management.
- Strategic asset management is also fundamental to finance management and setting water prices. The development of strategic asset management plans in Pakistan would allow the following:
 - shifting the focus to management ;
 - linking strategic asset management to corporate planning to emphasize the relationship between the quality of service delivery, the performance of assets, and the revenue generated for servicing the assets and providing the service; and
 - integrating strategic asset management with outputs by developing service delivery strategies that satisfy stakeholder objectives while maximizing the efficiency of resource allocation.

The general thrust should be to provide better value for money in service delivery, to improve accountability for the use of scarce resources, and to adopt more commercial disciplines in managing public finances.

With competing pressures on resources available for service delivery, it is essential to consider the full cost of an asset over its entire lifetime. These costs include acquisition, operation, maintenance, and replacement/renewals and are a significant part of the total cost of service delivery.

Other key considerations for managing assets are the following:

- strategies based on asset management plans that meet the needs of agencies and of the government as a whole;
- asset sales;
- optimizing (and rationalizing) assets to meet future needs;
- constraints on capital funds;
- involving the private sector in future infrastructure through leasing or build and operate arrangements;
- developing an integrated policy framework for strategic management of assets.

Strategic asset management plans require a legal framework to ensure successful implementation and require service providers to take certain actions (their obligations under the framework) to ensure the continuity of the services they provide to customers. This includes documenting service standards (set by the service provider) as well as an operation, maintenance, and renewal strategy for achieving these standards.

Develop Individual and Institutional Skills (\$10 million over 5 years; responsible agencies Ministry of Water and Power, Pakistan Engineering Council, HEC, universities)

The objective of capacity building in the water sector in Pakistan is to improve the management of water resources, principally in the Indus River Basin. To achieve this, some elements need to come together. The first is capacity building of and support for federal and provincial institutions in water resource planning and management through developing modular curricula in association with the Pakistan Engineering Council, universities and international water education collaborators. It includes, among other things, support for building human resources and institutional capacity in federal institutions and support for developing studies, strategies, and plans for improving water resource planning and management.

The second element is improving water resource management and development including (i) upgrading existing tools, databases, models, and management systems; (ii) sediment management studies for the Indus system including the possibility of flushing sediments through important reservoirs in the country such as the Tarbela Reservoir and its impact basin wide; (iii) an investment plan that focuses on infrastructure development in the upper Indus.

The third element is management coordination, additional studies, and training. This component will support the government, in particular the Ministry of Water and Power, with project management including coordinating all project activities and monitoring and evaluating project impacts and technical and financial audits. This will also support institutional strengthening and training of staff involved in water resource management.

There is also a need to focus on universities and to encourage students to excel in analyzing situations and recommending practical solutions. Along these lines, strong links should be developed between universities and the custodians of the knowledge systems. This should include a robust analysis of groundwater use, the creation of storage space in upper layers, the risk of overuse, and the management of salts.

Pakistan's institutions face more complicated problems and situations every day. The challenges are mostly not new, but there are new resources and ways to deal with them. For example, new technologies in flood and drought prevention and forecasting open a new field of possibilities for improving the current system. New technologies require technically skilled operators. This requires the institutions to hire new specialists. In order to handle the future challenges of the water sector, Pakistan needs to rethink some of the roles of the participants.

Today an engineer faces different challenges, needs, and demands. This makes every job a process of lifelong learning that is usually a mix of theoretical training, on-the-job exercises, and general knowledge of interdisciplinary studies. The training needs identified in the WCAP report are given on the facing page.

Training Needs that Can Be Filled in Foreign Countries

- ice and glaciology (temperature elevation run-off modeling)
- remote sensing and geographic information system for river survey and hydraulics
- rainfall harvesting techniques
- modeling for integrated management of water resources and power generation of a river basin
- underground dams
- roller-compacted concrete construction
- tunnel construction and maintenance
- sediment measurement, management, and control
- SOBEK – hydrodynamic river flow simulation model for flood forecasting in the Indus Basin
- hydropower engineering
- soil and rock mechanics
- radar meteorology (image interpretation of radar products output for rainfall runoff for flood protection)
- satellite meteorology (image interpretation of satellite)
- physical modeling (advanced techniques)
- latest discharge measurement techniques, training and equipment (canals, rivers and barrages)
- enhancing/ upgrading the Indus Basin model
- computer applications in water resource management (water availability, discharges, measurement, conservation water audit, water losses)
- design of powerhouses and hydraulic channels
- water accounting and auditing
- international water laws

Local Training

- land and water management
- groundwater exploration, its optimal but judicious use
- involvement and training of communities/farmers' organizations in monitoring and managing groundwater
- groundwater modeling
- water resource engineering
- hydropower engineering
- sediment transport and river engineering
- planning and developing hydropower projects
- water resource system analysis
- snow and ice hydrology
- watershed planning and management
- design of hydraulic structures
- catchment hydrology
- dam safety
- environmental impact assessment
- dam and reservoir engineering
- irrigation engineering and management
- analysis of soils/catchments and their effects on runoffs
- design of small hydel projects (on canal water and barrages)
- preparation of unit hydrographs
- telemetry system for the Indus Basin (meteor-burst communication based)
- digital and geographic information system-based database to integrate satellite images, management information system with web-based interfaces
- flow forecasting model for water availability (reservoirs, river inflows)

Build a Knowledge Base for Groundwater Management (\$5 million, responsible agencies Ministry of Water and Power, WAPDA, PIDAs, PIDs and the Pakistan Space and Upper Atmosphere Research Commission [SUPARCO])

The knowledge base should focus on the following.

- Develop an understanding of the potential and a mechanism for concurrent management of groundwater in the Indus system looking at groundwater flows, salinity, and the risk of upcoming, and groundwater movement and an understanding the scope for water reallocation and substitution and recharge from high flows.
- Develop a better understanding of cost-effective recharge, retention, and reuse methods appropriate for the different contexts in Pakistan (outside/inside the Indus Basin) and the opportunities to combine them with dam management and surface irrigation management.
- Share information on local water resources, especially on groundwater, pro-actively with those mainly concerned including farmers using visual and local language materials as an input to discussing better water management making a strong link between the knowledge base to be developed and case-based learning at universities and short-term practical courses for mid-career water professionals.
- Develop public-private partnerships for groundwater use and management suited to field conditions.
- Raise awareness and involve communities in checking the pollution of surface and groundwater bodies through unchecked discharge of industrial, agricultural, and sewage effluents to protect safe drinking water.

Establish a Center for Integrated Water Resource Management (\$6 million over 6 years; responsible agencies Ministry of Science and Technology, Pakistan Council of Research in Water Resources, and universities)

In order to achieve the critical expertise to establish a sustainable platform for adopting international state-of-the-art technologies for risk assessment of floods, drought, and cyclones, and to set up viable warning and dissemination systems, it is proposed to establish a center for integrated water resource management under the Ministry of Water and Power closely linked with a number of universities in Pakistan and abroad.

The center will be staffed with professional technicians and scientists both from existing public and scientific institutions and from the private sector. Through dedicated training and technology transfer, the staff will acquire the skills necessary to implement international state-of-the-art technologies and set up operational flood, drought, and cyclone forecasting and warning systems for the public institutions responsible for preparing and disseminating such warnings. At least 30 to 40 professionals and experts will be required to fulfill all the roles and obligations envisioned. In addition, a similar number of technicians, support, and management staff will be needed.

Establish a Platform for Sharing Data using IT and Satellite Technologies (\$2 million; responsible agencies Ministry of Water and Power, WAPDA, IRSA, SU- PARCO)

With modern satellite technology and other monitoring instruments, it is today possible to deliver timely information about weather and water. Computers can also predict future developments and their actual probabilities. Advanced IT infrastructure is necessary to host the datasets for sharing among the responsible organizations. Some of the IT challenges are the following.

- Centralize surface and groundwater information with proper metadata to build trust among all stakeholders.
- Build a knowledge base on the multiple functions of the irrigation and drainage systems in Pakistan. There is scope for more productive fisheries in canals and drains, for the development of commercial forestry along canal banks, and for the general development of water fronts and the sourcing of water to cities and industries, including managing water pollution.
- Integrate surface and groundwater information and improve its accessibility through a centralized database. There is also a need to address data gaps, for example, monitoring groundwater (quality, levels) in Sindh and in parts of Khyber Pakhtunkhwa, FATA, and Balochistan.
- Build trust and make the information available as reliable communication products for people to act on including municipal water managers, farmers' organizations, and civil society organizations. This will require proactively transforming the information into decision support applications to be shared with water managers and users.

IT technologies have proved to be important tools for collecting and diffusing information for community education. This will require developing visual material in languages other than English. A successful example is groundwater management in South India where farmers in overstretched areas drastically changed their pumping behavior following participatory hydrological monitoring and joint crop planning.

Build a Knowledge Base on the Impact of Climate Change on Glaciers (\$2 million; responsible agencies WAPDA, Global Change Impact Study Centre, PMD and ICIMOD)

Climate-change induced GLOFs could cause significant human and economic devastation. Concerns about the impact of climate change on the Indus, based on an assessment of what might happen given temperature changes in line with global climate change projections, have given rise to expectations of dramatic decreases in river flows. Such concerns have been supported by reports of significant retreating and depletion of glacial volumes across the Himalaya-Karakoram-Hindukush; however, the effects of climate change on glaciers and on river flows in the western part are not yet clear.

Accurate and comprehensive knowledge of glaciers and glacial lakes are of the utmost importance to understand and manage the risk of GLOFs in northern Pakistan. At present, the country faces a critical gap in knowledge of hydrological forecasting, risk mapping, and disaster prevention planning. The information currently available about the glaciers in the watershed of the Indus Basin is limited and scattered, and the understanding of the snow and ice conditions associated with the mountainous headwaters of the Indus is largely inadequate.

There is a critical need to monitor glaciers in order to understand both the role of glaciers in the hydrologic cycle and their response to warming climate trends. The following tasks are urgently needed.

- Review ongoing studies on the hydrological impacts of glaciers.
- Improve coordination and the exchange of information among the different organizations involved in monitoring glaciers in the region.
- Understand connections between weather, glaciers, and downstream floods. What is the future sustainability of this source?

- Improve the capacity of scientists and institutions in the region to apply advanced methods and technologies (including the use of satellite images) in assessing the status of snow and glaciers, and the impact of climate variability on them.
- Start an awareness raising program for national and regional policymakers on the predictions for and risks posed by melting mountain glaciers including issuing early warnings of GLOFs.

It is proposed that an interagency team of scientists and planners lead this work. This team should include field geologists, hydrologists, and glaciologists specializing in the northern region from the Geological Survey of Pakistan, remote sensing experts from SUPARCO, hydrologists with a basin-scale perspective from PMD, geotechnical experts from the Pakistan and Chinese Army Engineers, planners from the Natural Disaster Management Authority associated with national risk assessment, climate experts from the Global Change Impact Study Centre, and relevant academics from Pakistani universities.

Roles and Responsibilities for Building the Water Knowledge Base

This annex has highlighted the need and demand for undertaking an interdisciplinary approach to developing a knowledge base and capacity building in Pakistan. This approach will require contributions from many organizations (both federal and provincial agencies, education, and professional bodies) and disciplines (including but not limited to engineering, geology, geochemistry, meteorology, glaciology, limnology, ecology, economics, management, law, and political science). This will help generate knowledge as well as improve practice by a generation of “specialized integrators” with firm grounding in a discipline and organization and an ability to understand other perspectives and to integrate across disciplines and organizations. This will require actions from both the federal government as well as the international donor community, including the Friends of the Democratic Pakistan as follows.

For the government

- With partners who have developed decision support tools for their operations (like e-Water Australia or the US Army Corps of Engineers) develop a basic architecture around which to start to build knowledge and capability modules to meet the highest-priority challenges.
- In collaboration with agencies like WAPDA, PIDs, and other public agencies dealing in water and with the private sector, identify the highest priority areas where knowledge/capability needs to be developed. Building on the agreed-upon master architecture, engage universities and research institutions in partnerships with operators to develop first-generation products.
- With the HEC in the lead but with active participation from key ministries and operating agencies in Pakistan and with the cooperation of agencies (like e-Water and the Commonwealth Scientific and Industrial Research Organization in Australia, the Mississippi River Commission and the US Geological Survey in the United States, and Waternet and the Netherlands Organization for International Cooperation in Higher Education) re-assess and re-structure the water activities funded by the HEC and others (including the focus of Pakistan's large Fulbright program).

For the FODP and other external development partners

- Facilitate the access of the government to the very best knowledge/capability efforts (such as those mentioned above) through twinning rather than one-off consultancy arrangements.
- Support long-term partnerships between consortia of Pakistani and foreign “smart operating agencies” and universities to develop the knowledge, tools, and capabilities that Pakistan needs in this vital area.

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