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### *The Current Water and Agriculture Context, Challenges, and Policies*

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# The Current Water and Agriculture Context, Challenges, and Policies

### Key Messages

- Multiyear storage in the Indus Basin remains limited.
- Water and food demands are likely to increase on a per capita basis and in aggregate terms, as population increases. Reliance on groundwater resources will continue. Falling water tables and increased salinity in many places may worsen.
- An array of allocation entitlements economically constrains the waters available for agricultural production and coping with climatic risks.
- Low water-use efficiencies and agriculture productivities are top concerns.
- A common set of water and agricultural policy challenges is complicated by several dynamic stresses and institutional shifts, including constitutional devolution from national to provincial levels.
- Most national and provincial development plans continue to focus on the role of infrastructure in addressing challenges of water and food security.
- Recent policy documents highlight the increasing importance of improving irrigation efficiency, improvement of yields, and the socioeconomic distribution of development opportunities and benefits, including food security.
- The important role that water management plays in the productivity of the agriculture sector is recognized in many different forums and policy reports. However, these linkages are not always comprehensively addressed (with systems-based models) in federal and provincial planning documents and budgets.

The Indus Basin Irrigation System (IBIS) has undergone profound changes and experienced increasing stresses in recent years. Several recent studies have heightened awareness of Indus water resources issues, notably the World Bank study *Pakistan's Water Economy: Running Dry* (Briscoe and Qamar 2006).<sup>1</sup> That study convened a team of experts to identify broad challenges and strategic choices facing the water sector in Pakistan.

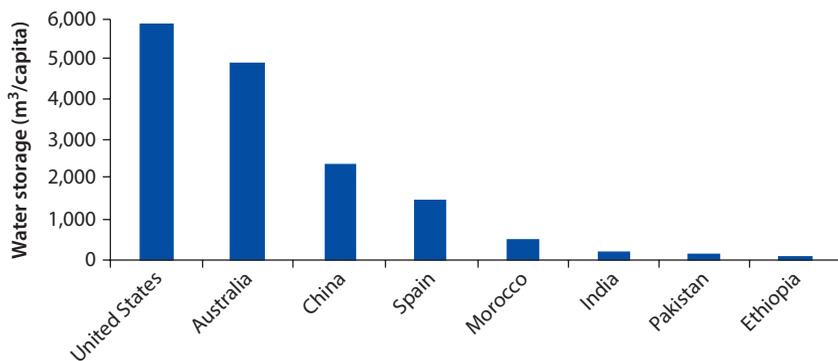
The key challenges that this modeling framework will examine in the context of climate risks are (1) limited water storage, (2) problematic trends in surface water and groundwater use, (3) inflexible and uncertain water allocation institutions, and (4) low water-use efficiencies and productivity. This chapter will also look at the various national policies and development plans to address these water and food security concerns.

### Limited Water Storage

It is well known that South Asian countries have a lower proportion of water storage and hydropower development than other regions of the world, both in relation to their geographical potential for storage and power generation and in relation to per capita water and energy use (figure 2.1).

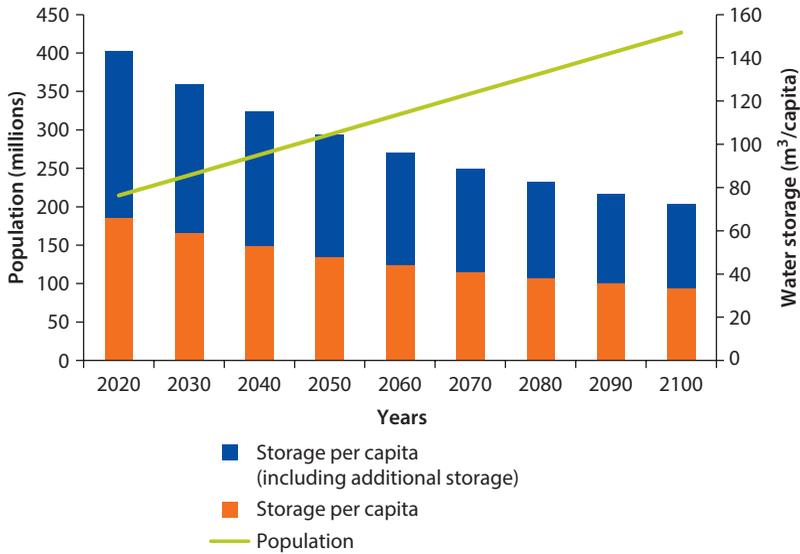
No major reservoir storage projects have been constructed since the completion of Tarbela Dam in 1976, and the system does not have multiyear carryover storage. The total storage is about 11 million acre-feet (MAF), representing about 10 percent of the total inflow in the system. This storage total is likely to decline with increased sedimentation into these reservoirs. This may constrain the quantity and timing of water releases for canal irrigation, and could have the greatest economic impact on the agricultural sector (Amir 2005a, 4). Moreover, figure 2.2 shows how storage per capita is likely to decline with continued population growth. Historically, reservoirs in Pakistan have been operated first for their irrigation benefits, and secondarily for their hydropower generation benefits. Interestingly, there appears to have been a major shift in sector benefit ratios. Work by Amir (2005b) suggests that the hydropower benefits of proposed dams at Basha and Kalabagh are estimated to be substantially greater than their irrigation benefits. The benefits from flood control are estimated to be even smaller. Amir (2005a) qualifies this generalization by noting that (1) Tarbela Dam has provided 22 percent of the surface irrigation deliveries in Punjab alone and has

**Figure 2.1 Water Storage per Capita in Semi-Arid Countries**



Source: Briscoe and Qamar 2006.

**Figure 2.2 Water Storage per Capita over Time**

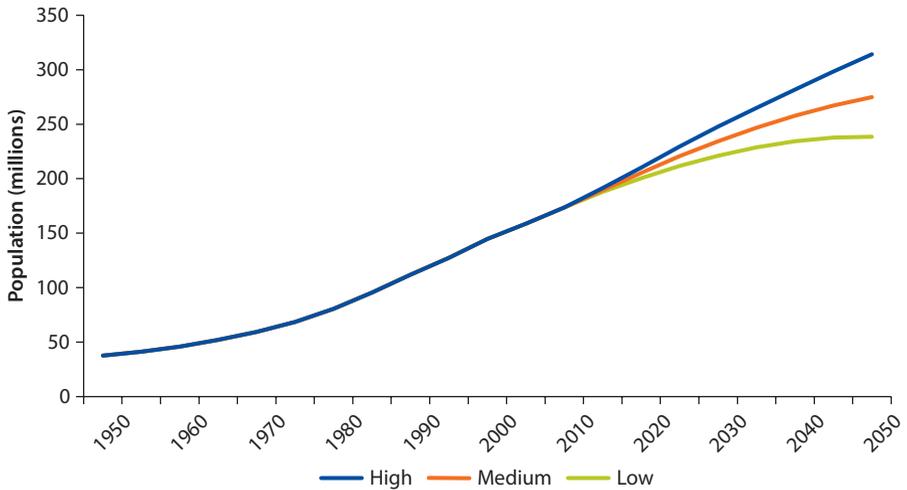


had substantially greater agricultural benefits than predicted, (2) reservoirs reduced the variability of water supplies for *rabi* crops and for delivering water to eastern canal commands during drought years, and (3) in wet years they have helped expand irrigated area and reduce the degree of deficit irrigation.

The *WAPDA 2025 Plan* (WAPDA 2004) identifies 22 storage projects in the IBIS. By 2011, some 800+ hydropower projects were identified, which would increase the nation’s estimated power capacity by some 30 percent (Government of Pakistan Private Power and Infrastructure Board 2011; Siddiqi et al. 2012). This analysis is particularly relevant in the wider South Asian regional context where there is now a “race to the top” to develop new reservoirs throughout the Hindu Kush-Himalayan region. Although annual flood control benefits are estimated to be far smaller than those of irrigation or power, they can be periodically significant, as evidenced by the economic impact of the floods of 2010. ADB and World Bank (2010) identifies the following key issues related to flood management: (1) the deferred maintenance of flood embankments resulting in structural failures, (2) insufficient storage capacity to absorb flood peaks, (3) lack of response mechanisms to early warnings, (4) need for expanding flood early warning systems, and (5) encroachment into flood plains and riverine areas. Post-flood assessments underscored the imperative of nonstructural as well as structural measures, and their relative and joint significance have yet to be established.

**Problematic Trends in Surface Water and Groundwater Usage**

A second area of concern is the changing relationship between surface and groundwater irrigation, with the underlying issues of (1) declining per capita water availability due to continuing population growth and (2) increasing rates

**Figure 2.3 Pakistan Population Prospects under Low, Medium, and High Scenarios**

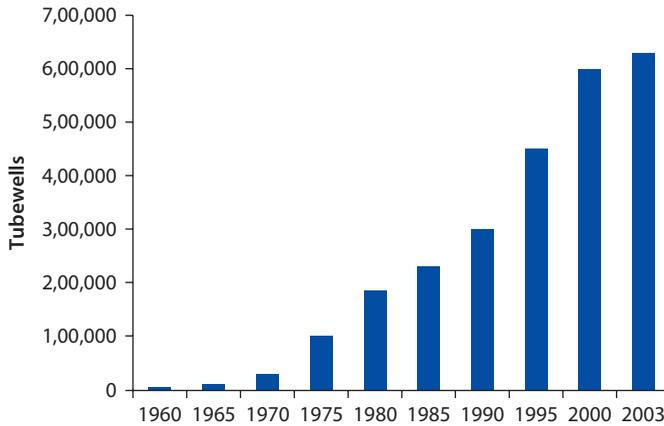
Source: UN Population Division 2012.

of groundwater pumping. Although the population growth rate in Pakistan has been declining, it is still 1.8 percent annually, which portends escalating demand for water, food, and fiber crops (World Bank 2012b). Even with the relative decline in the population growth rate, today's 174 million are projected to be 238 million to 314 million by 2050 (UN Population Division 2012) (figure 2.3). Will land and water resources suffice for this population? Moreover, water availability per capita has fallen drastically from 5,650 m<sup>3</sup> in 1951 to 1,000 m<sup>3</sup> in 2010. And by 2025, this number is projected to fall to 800 cubic meters (m<sup>3</sup>) per capita (GPPC 2007), well below the 1,000 m<sup>3</sup> per capita limit below which the supply is defined as "water insecure" (Falkenmark et al. 2007).

Land use from the late-19th to early 20th century involved a dramatic shift from a pastoral landscape punctuated by localized shallow well irrigation to the largest contiguously managed canal irrigation system in the world (Bedi 2003). By the second half of the 20th century, private tubewell development had accelerated (figure 2.4) as a means to reduce waterlogging and provide a more reliable and timely water supply for irrigation (Michel 1967). These processes enabled the reclamation of agricultural land to grow. Cropping intensity also increased in many areas from one to two crops per year, which has contributed to the continuing growth of withdrawals for agriculture. More recent data suggest that tubewell development has been leveling off during the current decade, perhaps due to increasing pumping costs, unreliable fuel supplies (mainly diesel), and decreasing groundwater quality.

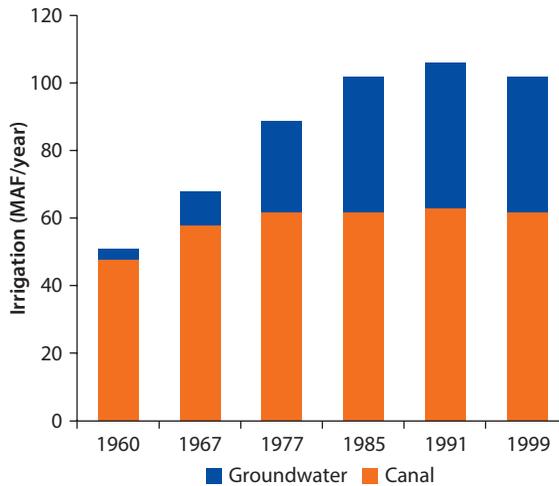
Irrigated land increased at an average annual rate of almost 1 percent from 1992 to 2008 (Government of Pakistan, Ministry of Food, Agriculture, and Livestock 2010). Figure 2.5 shows the change in irrigation source over time (Van Steenberg and Gohar 2005). Indeed, most farmers are currently using

**Figure 2.4 Growth in Use of Tubewells, 1960–2003**



Sources: Van Steenberg and Gohar 2005; in Briscoe and Qamar 2006.

**Figure 2.5 Growing Role of Groundwater Irrigation, 1960–99**



Sources: Van Steenberg and Gohar 2005; in Briscoe and Qamar 2006, 41.

Note: MAF = million acre-feet.

a combination of canal and tubewell water, while a smaller proportion relies solely on tubewells. Food and Agricultural Organization of the United Nations Statistical Database (FAOSTAT 2012) data estimate groundwater withdrawals at 34 percent of total withdrawals for all uses, which is probably conservative. Canal irrigation remains enormously important, though it has been slowly declining as the predominant source of water. Further opportunities for expanding irrigation into areas of rainfed (*barani*) cultivation are limited, although they include expansion of private tubewell irrigation, watercourse extension, and high-efficiency irrigation technologies that can operate on uneven terrain (for example, drip systems). These opportunities vary by province.

Increasing reliance on groundwater is no doubt related to problems of waterlogging, salinity, and, in some areas, groundwater depletion. Before an extensive canal irrigation network was developed in the Indus Basin, it was a land of monsoon-flooded riparian corridors between the dry upland plains of the great *doabs* and deserts. As irrigation historians of the Indus have shown, the colonial and post-colonial canal system had extensive seepage and spread vast quantities of water over the land that raised the groundwater table dramatically (figure 2.6; Gilmartin 1994).

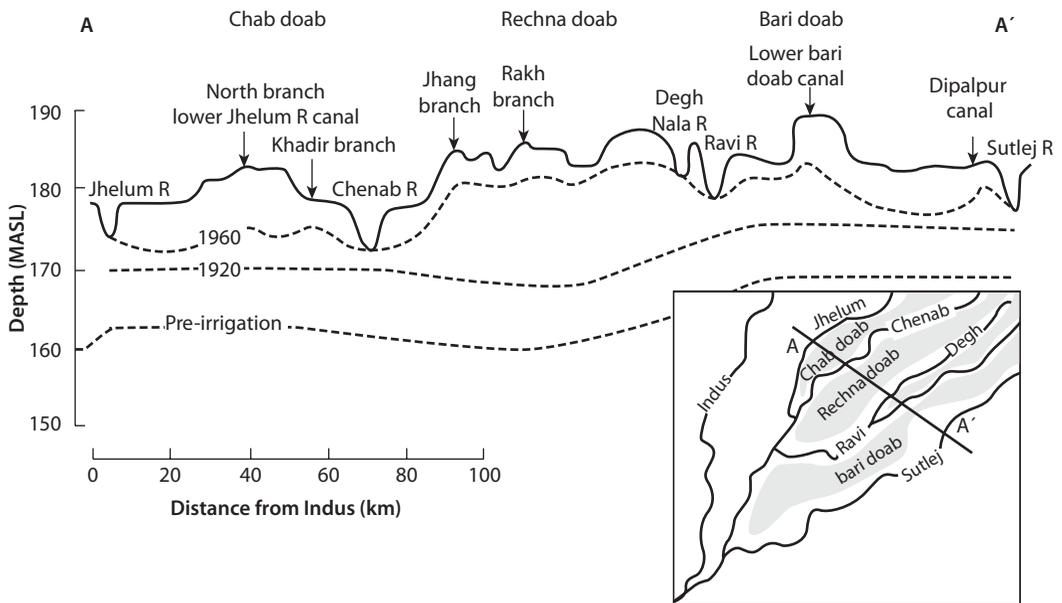
Drawing down groundwater can improve the waterlogging situation, but it can also increase pumping costs or it can tap into increasingly brackish waters. Figure 2.7 shows the particularly high proportion of shallow groundwater in Sindh province, although it varies across years.

A closer look at recent well records of water table depths shows significant differences over space and time. In the northern district of Sialkot in Punjab, for example, where water table levels are relatively high, water tables have fluctuated between 4 and 16 feet below the surface (figure 2.8).

The overall regional pattern shows decreasing water tables, thus decreased waterlogging, in the basin. To understand the potential impacts on agricultural production and yields, the variability of water levels and waterlogging must be compared with changing irrigation patterns and climatic conditions.

The areas affected by waterlogging and salinity have been monitored, but the costs of this environmental degradation are difficult to estimate. A recent

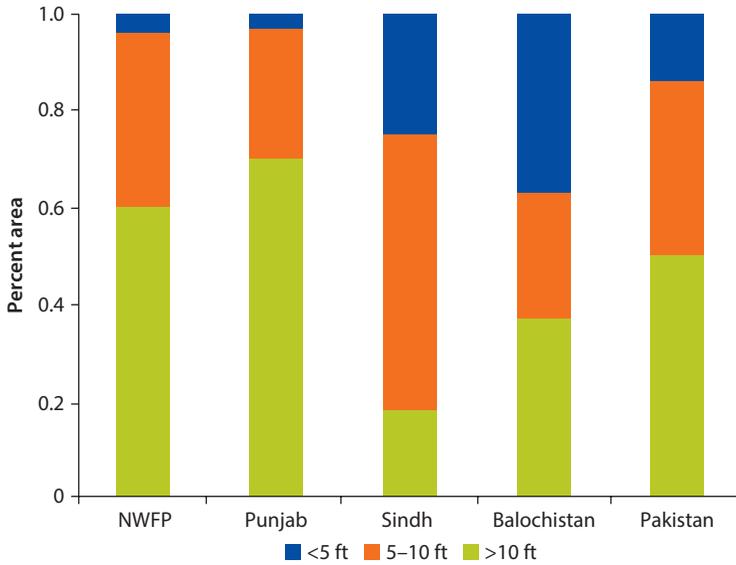
**Figure 2.6 Historical Changes in Groundwater Levels**



Sources: Bhutta and Smedema 2005; in Briscoe and Qamar 2006.

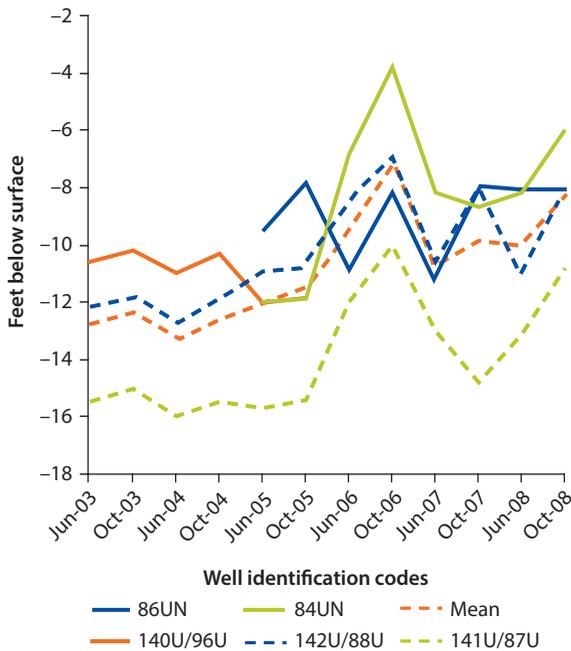
Note: MASL = meters above sea level, km = kilometers.

**Figure 2.7 Depth of Water Table by Province**



Source: Van Steenberg and Gohar 2005; in Briscoe and Qamar 2006.  
 Note: NWFP = North-West Frontier Province.

**Figure 2.8 Water Table Trends for Wells in Sialkot District of Punjab, 2003–08**



Source: Punjab Irrigation Department 2009, 12.

study by Bhutta and Smedema (2005) noted that the direct annual agricultural damage (not counting the lost opportunities of more profitable land use) is estimated to be on the order of PRs 20 billion per year. Waterlogging and salinity have also adversely affected public health and sanitary conditions in the villages. A more recent national estimate of the economic impacts of salinity on agricultural production examined two scenarios, one that emphasizes cotton planting on the most saline lands and the other, wheat. Estimated crop production losses ranged from PRs 30 to 80 billion in 2004 prices (World Bank 2006, 26).

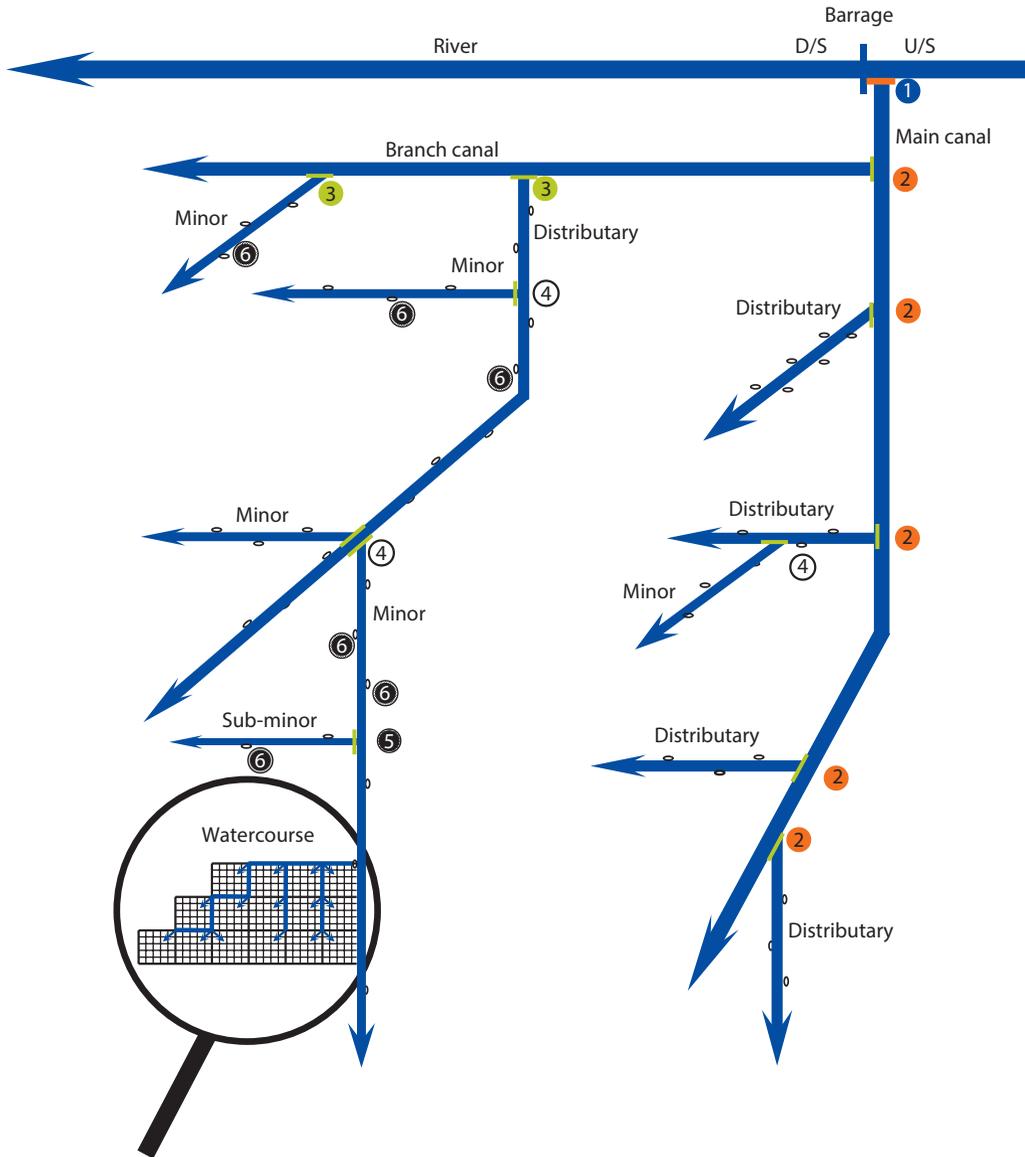
Groundwater quality issues are even more spatially complex and pose variable threats to agricultural sustainability. Overall salt balance models have been estimated, but as Ahmad and Kutcher (1992) have shown, the main challenge is modeling the dynamic spatial distribution and transport of salts through the irrigation system. As with waterlogging hazards, salinity hazards tend to accumulate downstream, affecting as much as 50 percent of the land in Sindh. However, recent village surveys indicate improvements in waterlogging and salinity in upper Sindh, as contrasted with increasing concerns in the deltaic region of Badin and Thatta districts (Berger and IAC 2011). Even in Punjab, salinity conditions vary by sampling well locations within a district and over time.

### **Inflexible and Uncertain Water Allocation Institutions**

An array of entitlements—from individual timeshare water rights (*warabandi*), to canal indents, a provincial water accord, and the Indus Waters Treaty (IWT)—shape the waters available for increasing agricultural production and coping with climatic risks. While private groundwater pumping is not regulated, surface water allocation institutions were designed with limited flexibility that constrain production under conditions of hydroclimatic variability and changing crop production technologies and functions. Additionally, these inflexible institutions have been routinely subverted to effect changes that privilege one group over another, undermine trust, and increase singular perceptions of even more widespread distortions. Two examples follow.

The canal water timeshare system is said to have been designed by colonial engineers to operate continuously under variable flow conditions with minimal involvement of the irrigators affected (Gilmartin 1994). Outlets (*moghas*) located on distributary and minor channels had fixed outlet sizes that were opened and closed for their respective shares based on farm size and duty of water under the 1873 Canal Act (figure 2.9). Over time, this system has been increasingly distorted through the modification of outlet sizes and timings to produce systematic inequities in waters that are over-allocated at the “head” of a canal leaving those at its “tail” deprived. Interestingly, Bhatia (2005) indicates that the presumed benefits of excessive diversions at the canal head may not always translate into net economic benefits at the canal head, as they can be offset both by excess water deliveries and less intensive or ineffective on-farm management. In addition, head-middle-tail inequities vary enormously in their magnitude and

**Figure 2.9 Canal Water Distribution System**



Transaction point	Water transaction	
	From	To
①	Barrage	Main canal
②	Main canal	Branch canals/ Distributaries
③	Branch canal	Distributaries/Minors
④	Distributary	Minors/Watercourses
⑤	Minor	Sub-minors/Watercourses
⑥	Sub-minor	Watercourses

	Barrage
	Head work
	Head regulator
	Mogha/Outlet
	Field
	Turnout

Source: Blackmore and Hasan 2005, 49.

impact on crop production (Hussain et al. 2003), variations that are sometimes interpreted as “low yields.”

### ***Indus Water Treaty***

Upon national independence in 1947, east and west Punjab were partitioned, and former princely states such as Jammu and Kashmir were placed in transitional status, which cut across the headwaters of the Indus tributary headwaters and created uncertainties for basin development in both Pakistan and India. Eight years of intensive negotiation with support from the World Bank yielded the IWT<sup>2</sup> of 1960 and a bold engineering and investment framework for the Indus Basin Development Programme (IBDP) in Pakistan (see Michel 1967 for a detailed history). The treaty allocated upper basin flows of the “eastern rivers” to India (Beas, Sutlej, and Ravi) and historical upper basin flows of the “western rivers” to Pakistan (Chenab, Jhelum, and Indus), with detailed specifications on future upstream development of the western rivers.

The impact of the IWT and IBDP in reshaping the IBIS cannot be overstated. They enabled construction of replacement works in Pakistan that included Pakistan’s two major storage dams (Mangla and Tarbela) and link-canals to transfer inflows from the western rivers to canal commands formerly supplied by the eastern rivers in Pakistan (see Wescoat, Halvorson, and Mustafa 2000 for a 50-year review of Indus Basin development). The Indus Basin Model used in this study was created to help guide investment in this highly complex agro-economic system.

The IWT (World Bank 2012a) has endured various stresses over time, and it has come under new pressures over upper basin development. In 2007, the IWT article that provides for the appointment of a neutral expert on issues that cannot be resolved by the parties was employed for the first time in the case of Baglihar Dam on the Chenab River.<sup>3</sup> In 2010, an International Court of Arbitration was convened to address Pakistan’s objections to the Kishanganga project under Article IX and Annexure G of the IWT. The IWT will likely continue to be tested as questions of climate risk, water, and food production become transboundary concerns. Although some question the future robustness of the IWT in light of the increasing scale of hydropower development and other trends, it has up till now worked reasonably as envisioned regarding international disputes.

Interestingly, multi-track efforts are under way among scientists, scholars, and former officials in India and Pakistan, the potential of which may be greater than has been realized to date.<sup>4</sup> Stochastic analysis of the joint and cumulative hydrologic and environmental effects of upper basin climate, runoff, and hydropower development processes could help identify paths for data exchange, confidence-building, data-driven negotiations, and expanding the range of choices among management alternatives.

### ***Indus Water Accord***

Since 1991, water inflows have been apportioned among the provinces by the Indus Water Accord. The Accord of 1991 allocated annual flows among

the provinces based on a five-year record of pre-Accord historical canal diversions. The Accord, which was based on the *assumed* average flow of 114.35 MAF of water in the Indus system, allocated 55.94 MAF of water to Punjab and 48.76 MAF to Sindh province, the remaining 9.65 MAF was divided between North-West Frontier Province (NWFP, currently known as Khyber Pakhtunkhwa) and Balochistan provinces (Mustafa and Wrathall 2011). Table 2.1 shows the minimum lump sum allocations across the cropping seasons.

Any surplus waters in a given year are distributed according to the following percentages:

- Punjab 37 percent
- Sindh 37 percent
- Balochistan 12 percent
- NWFP (Khyber Pakhtunkhwa) 14 percent

The Indus River System Authority (IRSA) was set up by the Accord of 1991 to manage provincial water demands for reservoir releases and distribution to canal commands. The “Council of Common Interests,” was introduced in the 1973 Constitution and reconstituted in 2009. It takes up disagreements among the provinces. IRSA does not have effective structures or mechanisms for regulating its political representation and technical administrative roles; the former is sometimes perceived to dominate the latter. In 2010, IRSA faced rising tensions leading to resignations and near-dissolution of its membership. Provinces have full authority to allocate their apportioned waters to various canal commands within their boundaries, which they do on a 10-daily operating basis. Few major canal commands cross provincial boundaries (though significant river flows, groundwater discharge, and drainage flows do cross provincial boundaries). While the Accord provides for excess flows and redistribution within provinces, it does not provide for extremely low flow conditions or negotiated transfers among provinces. A key analytical question is: How do

**Table 2.1 Allocations per the Indus Accord**

*million acre-feet*

<i>Province</i>	<i>Kharif<sup>a</sup></i>	<i>Rabi<sup>b</sup></i>	<i>Total</i>
Punjab	37.07	18.87	55.94
Sindh	33.94	14.82	48.76
NWFP <sup>c</sup>	3.48	2.30	5.78
Balochistan	2.85	1.02	3.87
Total	77.34	37.01	114.35

*Source:* Mustafa and Wrathall 2011.

*Note:* NWFP = North-West Frontier Province.

a. kharif period = April to September, spring planting season.

b. rabi period = October to March, winter planting season.

c. NWFP Civil canals = additional 3.00 million acre-feet.

these institutional constraints affect agricultural production patterns, values, and efficiencies?

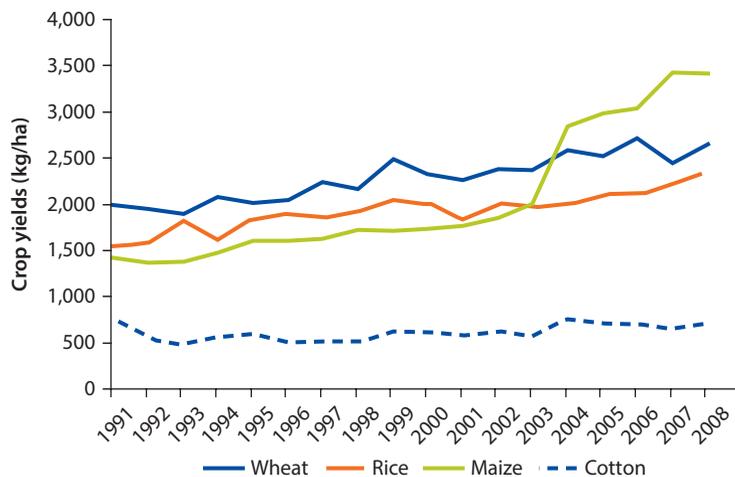
### Low Water-Use Efficiencies and Productivity

Low water-use efficiency and agricultural productivity are top concerns for the Government in Pakistan. Frequent comparison between low irrigated crop yields in Punjab, Pakistan, and Punjab, India (Ahmad 2005) find that both regions have lower yields compared to elsewhere (table 2.3). These comparisons are striking, but they are not as simple as they appear. Figure 2.10 shows that there has been slow growth in the overall trends in crop yields from 1991 to 2008 for all but maize. This may reflect a wide range of agronomic, economic, and technological factors. To what extent are yield differences based on water allocation differences, as compared with other inputs and resource conditions?

Low water-use efficiencies raise a comparable question. Efficiencies in the IBIS system comprise canal efficiencies, watercourse efficiencies, and field efficiency, measured as a percentage of water delivered relative to the amount withdrawn. When multiplied, they give a measure of system-wide water-use efficiency. Typical losses in Pakistan are shown in table 2.2.

Some irrigation scientists argue that subsequent reuse through pumping of canal seepage should be added, which would lead to higher estimates of system efficiency (Jensen 2007). Others argue for a shift from physical water-use efficiency to water productivity, measured either in terms of quantity of crop produced per cubic meter diverted and delivered, or in terms of the net caloric or economic value of that crop per unit of water (Molden et al. 2010). There are many ways to increase water productivity, from established techniques of watercourse improvement, precision leveling, and on-farm water management,

**Figure 2.10 Trends in Crop Yields, 1991–2008**



Source: Government of Pakistan, Ministry of Food, Agriculture, and Livestock 2010.

**Table 2.2 Seepage Losses in Irrigation System**

<i>Location</i>	<i>Delivery at head, MAF</i>	<i>Losses</i>	
		<i>percentage</i>	<i>MAF</i>
Main and branch canals	106	15	16
Distributaries and minors	90	8	7
Watercourses	83	30	25
Fields	58	30	17
Crop use	41	n.a.	n.a.
Total		61	65

*Source:* GPC 2005.

*Note:* n.a. = not applicable, MAF = million acre-feet.

to substitution of high-efficiency drip and sprinkler irrigation technologies for some crop and land types, as well as shifts to new crop types, varieties, and cultural practices. In a large system like the Indus, these alternatives have complex spatial as well as technological and economic linkages that need to be addressed through quantitative modeling.

## National Policies and Plans on Water and Agriculture

National policies affect all sectors related to Indus Basin management. Of particular relevance are a recent constitutional change and a suite of long-term and short-term economic plans and budgets. These plans have had to address volatile economic and political conditions. During the past decade, Pakistan's real rate of gross domestic product (GDP) growth increased from 2 percent in 2001 to 9 percent in 2006 as a result of a combination of economic reforms, the end of a multiyear drought, and increased foreign funding related in part to the conflict in Afghanistan.

Increased growth reflected a combination of international and domestic factors. Pakistan took on a large international debt position during this period, which made it vulnerable to shocks such as the Kashmir earthquake in 2005, the global food price spike in 2008, and the ensuing economic recession, and Indus floods of 2010—all of which contributed to the drop in GDP growth rate to 2.7 percent by mid-2011 (World Bank 2012b). An IMF (2010) standby agreement extension strives to manage debt, in part through fiscal policies such as increasing tax revenues, privatization, and lowering subsidies. International economic pressures, coupled with domestic and international security problems, have eroded funding for water and agricultural development.

### Constitutional Change

The 18th amendment to the Pakistan Constitution, passed in April 2010, eliminated the concurrent list of federal and provincial responsibilities and devolved most of the functions on that list to the provincial level. These functions include agriculture, including livestock and dairy; environment; and water management.

As an autonomous federal body, the Water and Power Development Authority (WAPDA) remains at the federal level, albeit with responsibilities limited to large water infrastructure planning, construction, and operations. As the Pakistan Meteorology Department (PMD) is under the Ministry of Defense, it also remains at the federal level. This constitutional change means that assessments of climate impacts and adaptation must devote increased emphasis on provincial planning, management, and governance. Further devolution of water management responsibilities to local government bodies has been attempted during the past decade and may resume in the future.

### **National Economic Long-Term Planning**

The current long-term plan for Pakistan is titled *Vision 2030* (GPPC 2007). Its chapter on “Agricultural Growth: Food, Water and Land” includes major sections on agricultural production, water management, food security, and climate change—the first time this suite of sectors has been jointly addressed in a long-term planning document for Pakistan. *Vision 2030* begins with the observation that Pakistan has low rates of agricultural productivity, measured in yield-per-ha, compared with peer producers of food and fiber crops (table 2.3).

*Vision 2030* proposes to address these gaps and minimize the impact of climate change in part by embracing the “gene revolution” (GPPC 2007, 53). Therefore, it is important to ask how crop breeding may affect water demand and, conversely, how hydroclimatic change could affect the productivity of new varieties. These uncertainties lie beyond current modeling capability and this report but may be an area for future investigation. At the same time, while *Vision 2030*’s projected crop yields increase relatively steeply between 2005 and 2010, but flatten out over the next 20 years (table 2.4), the question is whether these targets are sufficient to meet food demands, given the future population demands and potential climate change impacts. This question is addressed in subsequent chapters on modeling.

Finally, the *Vision 2030* report—using the threshold of 1,000 m<sup>3</sup>/capita after 2010 and assuming a persistent high population growth rate—argues that

**Table 2.3 Average Yields (kg/ha) of Selected Crops in Various Countries, 2005**

Country	Wheat	Cotton	Rice (paddy)	Maize	Sugarcane
World	2,906	1,949	4,019	4,752	65,597
China	4,227	3,379	6,266	5,153	66,063
India	2,717	850	3,007	1,939	61,952
Egypt, Arab Rep.	6,006	2,603	9,538	8,095	121,000
Mexico	5,151	n.a.	n.a.	2,563	70,070
France	6,983	n.a.	n.a.	8,245	n.a.
Pakistan					
National Average	2,586	2,280	1,995	2,848	48,906
Progressive farmer	4,500	2,890	4,580	7,455	106,700

Source: GPPC 2007, 52.

Note: n.a. = not applicable.

**Table 2.4 Crop Yield Targets of Major Agricultural Products**

tons, millions

Agricultural product	Benchmark		Production targets	
	2004–05	2009–10 <sup>a</sup>	2015 <sup>b</sup>	2030 <sup>c</sup>
Wheat	21.6	25.4	30.0	33.0
Rice	5.0	6.3	7.5	8.5
Cotton (lint) <sup>d</sup>	14.6	17.0	30.7	21.5
Sugarcane	45.3	56.7	63.4	n.a.
Fruits	6.0	7.0	10.8	n.a.
Oil seeds	5.8	7.5	8.12	n.a.
Meat	2.8	3.1	4.2	n.a.
Milk	29.4	43.3	52.2	n.a.
Fisheries	573.6	725	n.a.	n.a.

Source: GPPC 2007.

Note: n.a. = not applicable.

a. Mid-term development framework, 2005–10.

b. Ministry of Food, Agriculture, and Livestock, 2015.

c. Production based on regression analysis of 16 years of data (1990–2005).

d. bales, millions.

**Table 2.5 Projected Sectoral Growth Rates during Mid-Term Development Framework Plan Period**

percentage per year

Economic sector	Sectoral shares 2008–09	Sectoral growth rates						Average growth rate <sup>a</sup>	Sectoral share 2014–15
		2009–10	2010–11	2011–12	2012–13	2013–14	2014–15		
Agriculture	21.8	3.0	3.5	3.6	3.7	3.8	3.9	3.7	20.1
Industry	24.4	4.5	5.0	5.5	6.0	7.0	8.0	6.3	25.8
Services	53.8	3.2	3.6	4.8	5.2	6.2	7.4	5.4	54.1
GDP	100.0	3.5	3.9	4.7	5.1	5.9	6.8	5.3	100.0

Source: Panel of Economists 2010.

a. Growth rate during plan period 2010–11 to 2014–15.

an additional 12 MAF of storage is needed. This also incorporates the current observed reservoir sedimentation and future projections of increased general circulation model (GCM) monsoon rainfall of 20–30 percent.

Similarly, a panel of economists submitted recommendations for the next *Medium-Term Development Imperatives and Strategy for Pakistan* for a five-year period, 2010–2015.<sup>5</sup> The “Panel of Economists Final Report” (2010) envisions the agricultural growth rate to average only 3.7 percent, due in part to water constraints (table 2.5). The report urges increased irrigation efficiency, which it describes as averaging only 37 percent (due to canal, watercourse, and field losses). It criticizes the fiscal shortfalls of an irrigation revenue system (*abiana*) that recovers only 35 percent of its operation and maintenance costs. The report further recommends accelerated adoption of Bt cotton to emulate India’s dramatic increase in yields in Bt cotton since 2002. The panel also advocates

preparing for climate change, though it does not draw upon any current research or make specific policy recommendations.

Note that the previous mid-term development framework (MTDF) (2005–10) gave more detailed attention to physical water infrastructure investment. It cited the limited reservoir storage capacity in Pakistan, storage losses due to reservoir sedimentation, and irrigation seepage losses that are estimated to be 65 MAF or 61 percent of the water diverted into major canals (table 2.2). Moreover, it sought to lay out a comprehensive framework for water resources management, along with support for 36 continuing and 15 new water infrastructure projects, totaling more than PRs 276 billion over five years. The Agriculture chapter of the MTDF, by comparison, makes limited reference to issues of water management, which reflects a sector gap between irrigation and agricultural policy.

Current federal economic plans and budgets shed light on a number of policy issues relevant for addressing climate risks, water, and food security in the near term. There is increasing recognition of climate change issues in federal planning, but no climate policy has been included in an annual or five-year development plan or budget to date. A climate change strategy was approved by the Federal Cabinet in January 2012, and a new Ministry of Climate Change was created in March 2012 that could guide future planning and budgeting. The strategy gave heavy emphasis to adaptation in the water, agriculture and livestock, forestry, disaster preparedness, and vulnerable ecosystems (mountains, coastal zone, rangelands, wetlands), and human health. It also includes a mitigation section focused on energy, transport, and industries. Despite this emphasis, current development plans do not indicate where climate change risks would be addressed at the federal level.

The Pakistan Planning Commission needs to consider alternative agency and inter-agency organization for climate change policies and programs. The Planning Commission and Ministry of Finance will also need to consider the linkages between climate change and disaster risk reduction policies. Devolution of former federal sectoral functions to the provinces under the 18th Amendment will require stronger policy linkages between the federal water sector and provincial agricultural sectors. This will require vision and budget support at the federal level.

### ***National Water Policies***

The primary policy document in the water sector at the federal level is the WAPDA *Vision 2025*, developed in 2001, which describes WAPDA's long-term infrastructure development plan. Proposed water projects are described on the WAPDA web pages and are almost entirely physical infrastructure projects (no reference to climate change). The written report, updated in 2004, presents the overall context and rationale for these projects. WAPDA has prepared a "Developmental Plan" that focuses on strategic issues and infrastructure completed, planned, and phasing; it makes no reference to climate change. A major Water Sector Strategy was drafted in 2002, and adopted in 2005, but still remains in draft form. Thus, there is no strong policy linkage between WAPDA's

*Vision 2025* for reservoir and hydropower infrastructure investment at the national level to increase storage and hydropower capacities, on the one hand, and the various provincial water sector policies that must address issues of water demand management and agricultural productivity, on the other.

National water policy is articulated in the Annual Plans of the Planning Commission and budgets of the Ministry of Finance. The most recent *Annual Plan 2011–2012* introduced the “Water Resources” sector as a balanced program of supply augmentation and irrigation management. The water sector plan and budget for 2010–11 had ambitious aims that had to be dramatically scaled back due to the 2010 flood and budget cuts. Quantitative targets in the two most recent plans indicated declining physical achievements and targets both before and after the 2010 flood. Although the plans indicated a partial shift from large projects to small- and medium-size projects, there are continuing efforts to advance Basha-Diamer and other large storage and hydropower projects central to WAPDA’s *Vision 2025*.

### ***Task Force on Food Security***

The 2008 spike in world food prices led the Government of Pakistan to set up a Task Force on Food Security, which delivered its final report in 2009 (GPPC 2009). Its key points are that Pakistan needs to develop: (1) a national food security strategy (supported by 4 percent annual agricultural growth rate, efficient and equitable storage and pricing, increasing food access through a pro-poor growth and employment, and transparent safety nets); (2) a food security index for monitoring purposes; (3) favorable terms for agricultural trade and increased agricultural credit; (4) capacity-building in the federal [now provincial] agricultural departments; and (5) legislation in the form of a Seed Act Amendment Bill and Plant Breeders Rights Bill.

The task force recommendations focus on agricultural growth through increased yields, a shift to higher value horticultural crops, and increased investment in the high-value livestock and dairy sector. Attention was also given to enhancing agricultural water management and water-use efficiency through precision land leveling, watercourse improvements, water-efficient irrigation technologies, low delta water crops, and promotion of water saving technologies like drip and sprinkler irrigation.

The report identified water as a major constraint in agriculture. A serious structural and administrative barrier to achieving the production targets set in the report is the stressed irrigation system, which is stressed due to inadequate maintenance and inefficient water use that adversely affects the water balance. Water shortages are particularly severe in the southern part of the country where irrigation has expanded into some of the driest regions. The non-economic water prices also provide no incentive to adopt recommended cropping patterns and water-saving techniques. Although the national water policy provides a legal framework for water pricing and cost recovery to ensure effective and efficient water management, its implementation is poorly managed. The inefficient use of water was cited as one of the major issues in the comparably low levels of crop

productivity—Pakistan’s cereal production of 0.13 kg per cubic meter of irrigation water compares unfavorably with 0.39, 0.82, 1.56, and 8.7 kg in India, China, the United States, and Canada, respectively (Kumar 2003).

The task force further recommended a two-pronged strategy for the development of water resources to attain and sustain food security in Pakistan. First, attention should be paid to reducing water losses and improving conservation of available water resources to enhance productivity and increase cropping intensity. This task should include the continuity of ongoing development projects (watercourse improvement and high-efficiency irrigation systems), and expanding the coverage of new initiatives and pilot activities, such as laser land leveling and permanent raised bed, furrow irrigation. Second, new small-scale irrigation facilities in rainfed areas and poverty pockets of fragile eco-zones should be developed. It is estimated that the present cropped area of 58.5 million acres can be increased by at least 12 million acres from the available culturable wastelands of 20.6 million acres in the country.

### ***Task Force on Climate Change***

The Government of Pakistan Planning Commission set up a Task Force on Climate Change in October 2008 to provide appropriate guidelines for ensuring the security of vital resources such as food, water, and energy. Their final report, drafted in February 2010 (GPPC 2010), contributed to the formulation of a climate change policy that has been helping the Government pursue sustained economic growth by addressing the challenges posed by climate change. The report acknowledged the limited scope for expanding water supplies and advised that Pakistan would have to improve the efficiency of water use in all the sectors, particularly in agriculture. It also warned of the risk of increased demand of irrigation water because of higher evaporation rates at elevated temperatures in the wake of reducing per capita availability of water resources and increasing overall water demand. The report predicted that the impacts on food security in the agriculture sector would mainly be through reduced crop productivity caused by extreme events (floods, droughts, and cyclones). Given these risks under the increasing pressure of a growing population, Pakistan has no option but to take major steps for increasing its land productivity and water-use efficiency.

### **Notes**

1. Includes 17 background papers.
2. Accessible online at <http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/SOUTHASIAEXT/0,contentMDK:20320047~pagePK:146736~piPK:583444~theSitePK:223547,00.html>.
3. <http://siteresources.worldbank.org/SOUTHASIAEXT/Resources/223546-1171996340255/BagliharSummary.pdf>.
4. For example, the Jang publishing group and Aman ki Asha sponsored a group of Indian and Pakistani leaders to discuss the prospects for international cooperation;

see <http://www.amankiasha.com/events.asp> in June 2010. Also the International Centre for Integrated Mountain Development convened a joint scientific meeting on the hydroclimatology of the upper Indus in 2010.

5. This medium-term planning timeframe is the functional equivalent of a five-year plan.

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