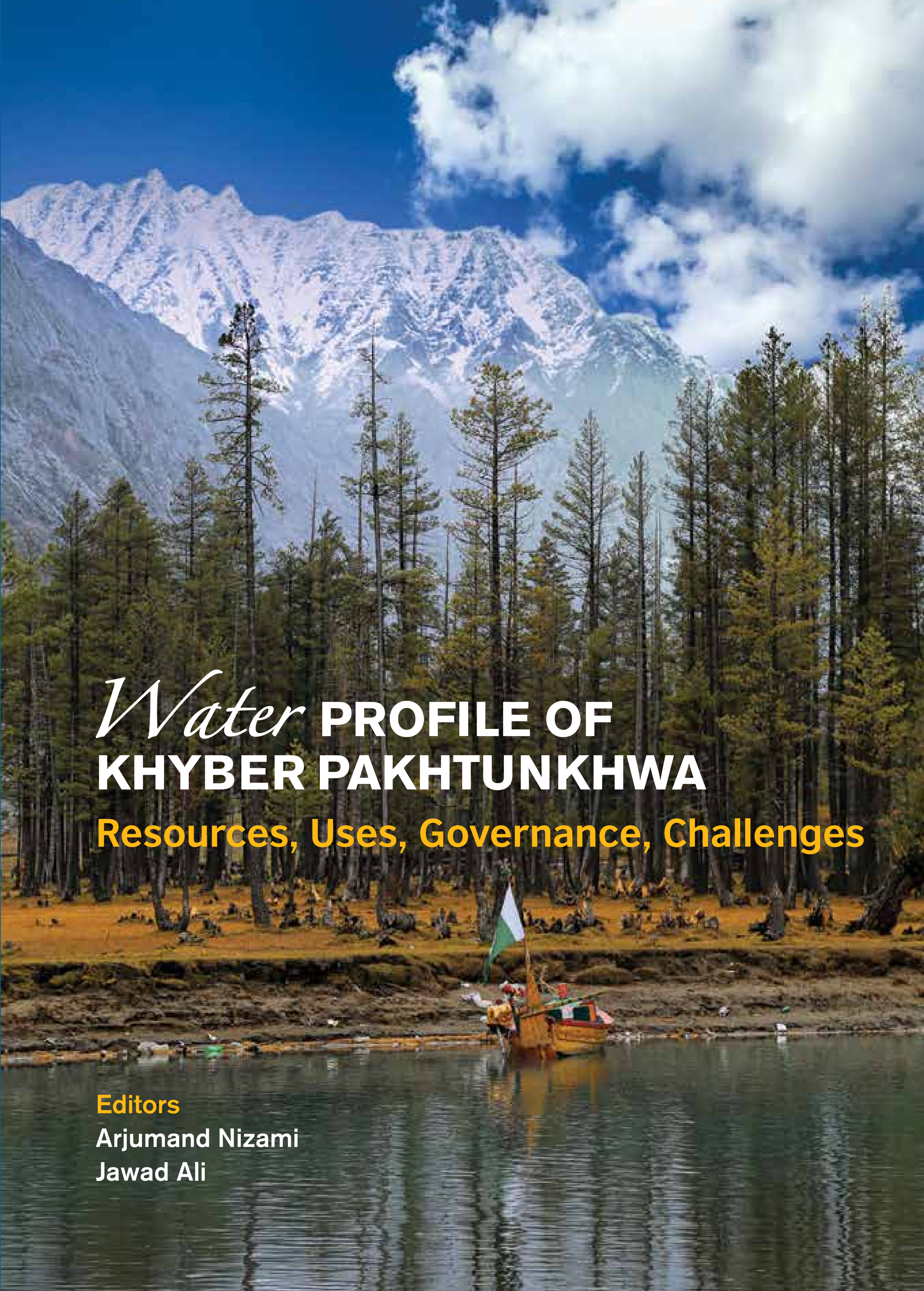

Water PROFILE OF KHYBER PAKHTUNKHWA

Resources, Uses, Governance, Challenges

Editors
Arjumand Nizami
Jawad Ali

Water Profile of Khyber Pakhtunkhwa

Resources, Uses, Governance, Challenges

Editors

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Dedicated to all the guardians of water resources in Khyber Pakhtunkhwa who have relentlessly performed their role to value their hydrological resources and used them efficiently with love and care for the future of Khyber Pakhtunkhwa.

Acronyms

ADB	Asian Development Bank
AJK	Azad Jammu & Kashmir
AKRSP	Aga Khan Rural Support Programme
BTTAP	Billion Trees Tsunami Afforestation Project
CCA	Culturable Command Area
CMIP5	Climate Model Inter-comparison Project (phase 5)
COP-10	Conference of Parties 10
CPEC	China Pakistan Economic Corridor
CRBC	Chashma Right Bank Canal
DG Khan	Dera Ghazi Khan
DBDP	Diamer Basha Dam Project
DG	Director General
DI Khan	Dera Ismail Khan
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
dS/m	decisiemens per metre
EPA	Environment Protection Agency
FAO	Food and Agriculture Organization of the United Nations
FATA	Federally Administered Tribal Areas
FD	Forest Department
FDC	Forest Development Corporation
FSMP	Forestry Sector Master Plan
GB	Gilgit Baltistan
GDP	Gross Domestic Product
GENCOs	(Power) Generation Companies
GIS	Geographic Information System
GLOF	Glacial Lake Outburst Floods
GoKP	Government of Khyber Pakhtunkhwa
GoP	Government of Pakistan
GWh	Gigawatt hour
Ha	Hectare
Helvetas	Helvetas Swiss Intercooperation
INGOs	International Non-Government Organizations
IPCC	Inter-Governmental Panel on Climate Change
IPPs	Independent Power Producers
IRSA	Indus River System Authority
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resource Management
KP	Khyber Pakhtunkhwa
MAF	Million Acre Feet

mm	Millimetre
Mm^3	Million Cubic Meter
MW	Megawatt
NC	Neighbourhood Council
NDWP	National Drinking Water Policy
NEQS	National Environmental Quality Standards
NESPAK	National Engineering Services of Pakistan
NGOs	Non- Government Organizations
NWP	National Water Policy
O&M	Operation and Maintenance
OFWM	On-Farm Water Management
P&D	Planning and Development
PCRWR	Pakistan Council of Research in Water Resources
PEDO	Pakhtunkhwa Energy Development Organization
PESCO	Peshawar Electric Supply Company
PFRI	Pakistan Forest Resource Inventory
PHED	Public Health Engineering Department
PHYDO	Pakhtunkhwa Hydel Development Organization
PKR	Pakistani Rupee
PMD	Pakistan Meteorological Department
PPIB	Private Power & Infrastructure Board
SDC	Swiss Agency for Development & Cooperation
SHYDO	Sarhad Hydel Development Organization
TMA	Tehsil Municipal Administration
TNO	Institute of Applied Geo Sciences, (known as TNO), The Netherlands
UNICEF	United Nations Children's Fund
USA	United States of America
VC	Village Council
W4L	Water for Livelihoods
WAPDA	Water and Power Development Authority
WASH	Water, Sanitation and Hygiene
WFP	World Food Programme
WSSCs	Water and Sanitation Services Companies
WSSP	Water and Sanitation Services Peshawar

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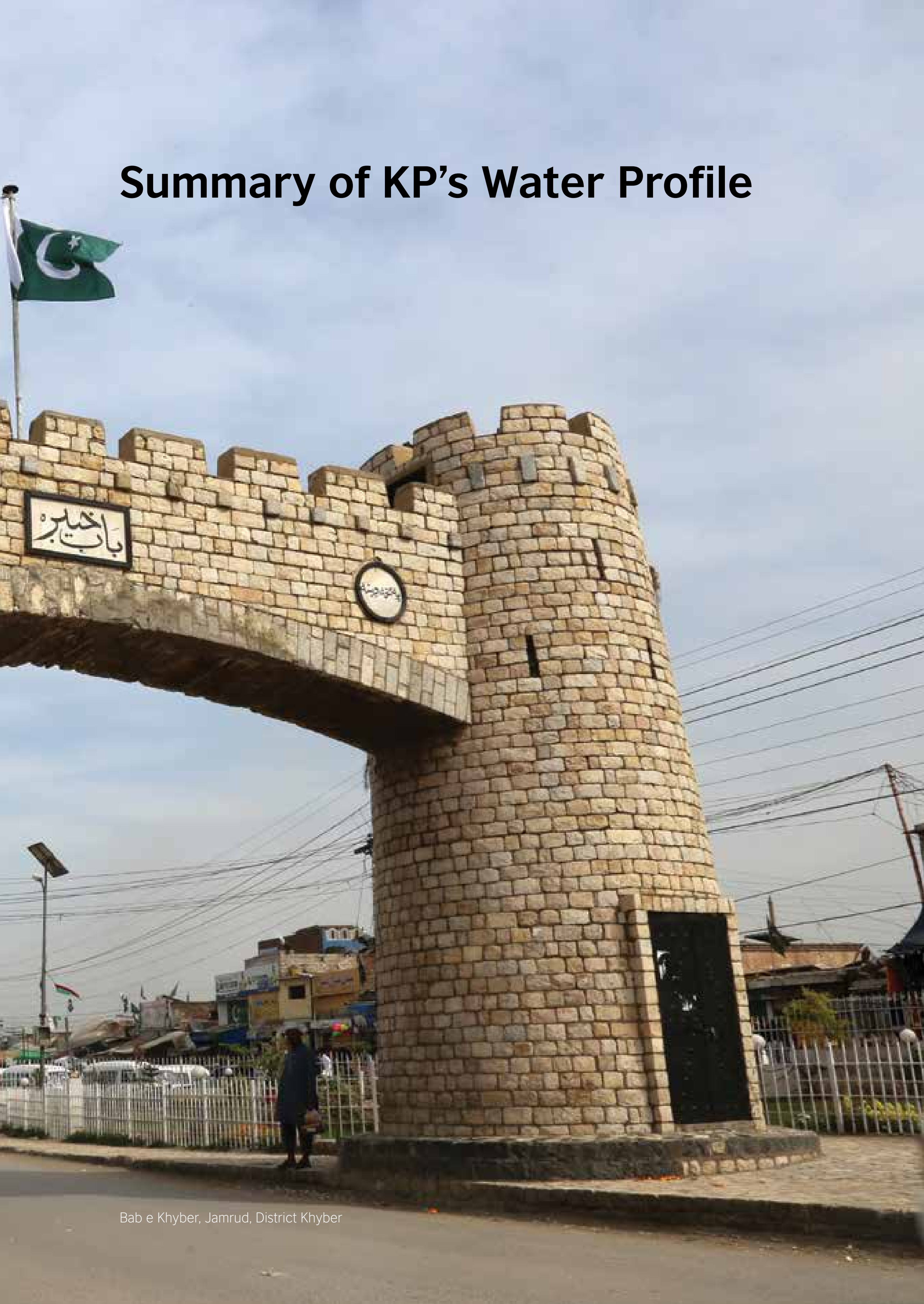
This book is the first ever effort to bring all the scattered knowledge together on water and water related sectors in the province. This knowledge capital has already resulted in the province's first Integrated Water Resources Management Strategy and a manual to conduct strategic IWRM planning at catchments level. We, therefore, take the pride as editors to set the first benchmark in water sector in the province. We invite experts to roll the ball for striving to achieve effective water governance and improved management of blue, green and brown water resources in the province for its citizens.

Editors

Summary of KP’s Water Profile



Bab e Khyber, Jamrud, District Khyber

Summary of KP's Water Profile

Many of the 35.5 million people (83.5% of them in rural areas) of the Khyber Pakhtunkhwa Province live in multi-dimensional poverty. Lack of access to water is a major driver of poverty and deprivation. The province has a diverse landscape of agricultural plains, drylands, mountains, and substantial seasonal variations. A large area of the province comprises highlands which are highly vulnerable to climate variability and change. They are also rich in water resources that play an important role in the regional hydrological cycle. This diversity is an opportunity as well as a management challenge.

Mountain landscape in District Chitral

Freshwater is essential for human life and sustainable development. This finite resource is facing competing demands and, therefore, needs to be managed holistically, engaging users, planners, and policymakers at all levels. Water use in Pakistan is dictated by the Water Apportionment Accord, signed in 1991, which stipulates the maximum volume of water that each province is entitled to use annually. An annual 8.78 Million Acre-Feet (MAF) of water, representing 7.5% of the national total, has been allocated to the Khyber Pakhtunkhwa province from the Indus Basin River System. By comparison, the annual volume allocated to other provinces stands at 55.94 MAF for Punjab, 48.76 MAF for Sindh and 3.78 MAF for Balochistan. Against its allocated 8.78 MAF, the province has the capacity to utilise 5.97 MAF, making an annual non-utilised resource of 2.81 MAF. This water needs to be utilised for the welfare of people in the area. Sources of water include rivers and streams totalling 6,100 kilometres, lakes covering 6,400 ha and dams and reservoirs covering 54,600 ha - which also yield around 3,200 tonnes of freshwater fish per year. The annual surface water flows are carried by the 11 major rivers and streams traversing the province. The total surface flow is about 29.51 MAF, including about 4 MAF from rivers and hill torrents from the newly merged tribal districts.

River Kunhar, District Mansehra

Khyber Pakhtunkhwa is endowed with a geographical land area of 12.89 million ha. From North to South, it covers a diversity of terrain, and experiences substantial seasonal variations. Land use data are available for 65% of the geographical area of the province. Out of the total reported geographical area, the cultivable area is 3.17 million ha (38%) of which 1.89 million ha (60%) is cultivated, leaving a significant area (40%) of non-cultivated, barren land. There is clear potential to bring this land under cultivation by extending the irrigation network to arid or semi-arid areas. Of the remaining area of the province, 16% is covered by forests whilst 46% is unsuitable for cultivation. Nearly 32% of the geographical area is arid and semi-arid in nature with less than 500 millimetres (mm) rainfall per annum. This is lower than the national figure; approximately 75% of Pakistan's total land area falls in arid (less than 250 mm rainfall per annum) and semi-arid (between 250-500 mm rainfall per annum). Some 31% of the total population of the province lives in the arid and semi-arid areas, largely depending on subsistence agriculture, livestock, wage labour, services, and remittances. Large scale commercial agriculture or industrial activity is highly limited in this region.

Dryland in District DI Khan

Khyber Pakhtunkhwa province has three main hydrological assets which need to be leveraged to generate local investment. These comprise the Indus basin in the centre, the *Rudh Kohi* catchment (hill torrents) in the South, and glacial highlands in the North. Where appropriate, the province needs to build new infrastructure, protect existing infrastructure, and address with urgency the improvement of water efficiency and productivity to optimize returns from the water value chain.

Diversity in KP (DI Khan, Charsadda, Chitral,)

Agriculture is the major source of livelihoods in the province, contributing about 24% of Gross Domestic Product (GDP) to the provincial economy. Agriculture also accounts for half of the employed labour force and is the largest source of foreign exchange earnings. Irrigation requirements in agriculture are mostly met through surface water (34% canal water, 30% groundwater, the remaining rainfed). The canal irrigation water efficiency is around 43%, meaning that less than half the water in the irrigation system reaches the farm gate.

Farmers in onion field, District Buner

Whilst there is some fluctuation from year to year depending on rainfall, on average the total surface water of Khyber Pakhtunkhwa, including that allocated from the Water Apportionment Accord, rainfall and hill torrents, is 17.38 MAF. Of this, on average 15.64 MAF (90%) is diverted into the irrigation system. The groundwater potential of the province is not known. A study conducted in 2020 covers only the central parts of the province. The annual groundwater extraction for agriculture and domestic uses is estimated at 3.97 MAF. Around 57% of the annual extraction is used in the agriculture sector; the rest is used for domestic purposes.

Three of the provincial canal systems i.e. Chashma Right Bank / Paharpur Canal System in DI Khan, Pehure Main Canal in Swabi and Pehure High Level Canal in Swabi take about 2.82 MAF water annually from the right bank of the River Indus. Beside these three canals fed by the Indus, a number of other canals have been constructed for irrigation purposes in the province. These include the Kabul River Canal, Lower Swat Canal System, Upper Swat Canal System, Warsak Canal System, Kurram Garhi Head Work, Baran Dam, Gomal Zam, and Bazai Irrigation Scheme. In addition, there are more than 3,000 civil channels within the districts (including newly merged districts) of the province. Civil channels are non-revenue channels that are maintained by the irrigators themselves. These civil channels utilise a sizable quantity of irrigation water (3.00 MAF allocated under Water Apportionment Accord). It is observed that the efficiency of most of these channels is much lower than the government canals.

Irrigation channels in districts Bannu, DI Khan and Chitral

Waterlogging and salinity have not been reported as key issues in Khyber Pakhtunkhwa, although Southern areas are vulnerable to this problem. The drier agro-ecological zones demand highly responsible agriculture with the adoption of water efficient farming techniques. Water productivity in agriculture in Khyber Pakhtunkhwa is far lower than the average for the country. For example, in Khyber Pakhtunkhwa 1,351 litres of water are required to produce one kilogram (kg) of wheat as opposed to the national average of 1,085 litres. Similarly, 1,136 litres of water are needed to produce one kg of maize compared against the national average of 710 litres. Hence there is a huge potential to improve the water use efficiency and water productivity in the province.

The Khyber Pakhtunkhwa receives comparatively higher average precipitation than the rest of the country. Climate trends indicate that whilst current average annual precipitation in the province is 738 mm, it will increase to 753 mm in 2030 but then decrease somewhat to 744 mm by 2040. Climate change is expected to change the water situation in the province with annual precipitation in most districts remaining stable or slightly increasing until 2030. However, in this period a temporal shift of precipitation is expected throughout the province, with increased rainfall during spring and summer resulting in more frequent water induced disasters, and reduced precipitation in winter and autumn. This will have an impact on water availability and thus crops. By the year 2040, 85% of districts will receive 14-18% less rainfall in winter than the amount received today. With exception of 13% of districts, there will be an annual increase in spring precipitation by the year 2040. In addition, most snowfall in mountainous region is likely to occur during early spring instead of winter, increasing overall spring precipitation. An overall increase in summer rainfall of 10-17% is expected by 2040, whilst autumn rainfall is likely to decline by 22-31% in 87% of districts by 2040. Total rainwater harvesting potential in the province is currently 4.13 MAF but will increase to 4.22 MAF in the next decade and then decline to 4.17 MAF in the following decade.

The annual rainwater potential in the province is about 3.71 MAF. So far, the province has been able to harvest about 0.28 MAF of local surface runoff through 31 small dams. The mountainous topography of the province has tremendous potential for small and medium dams. The history of small dam construction in the province started in the early sixties with the construction of the medium scale Baran dam in Bannu. Three other small dams, namely Tanda and Kandar dams in district Kohat and Khal dam in district Haripur were also completed in the same decade. Despite the huge potential, the provincial government paused for twenty years in continuing this work; no further dam construction took place until 1984. However, the situation of rainwater harvesting and storage in the province is expected to improve shortly with the construction of the Mohmand, Gomal Zam, and Kurram Tangi dams; an additional 33 small dams are also planned within the next few years.

Hydropower resources in Pakistan are mainly located in mountainous areas in the North of the country, notably in Khyber-Pakhtunkhwa, Gilgit-Baltistan and Azad Jammu and Kashmir. Pakistan is blessed with a huge total potential of 100,000 mega-watt (MW) hydropower, with a current identified potential close to 60,000 MW. The current installed capacity of the country is only about 7,000 MW. Out of the 60,000 MW identified potential, 24,736 MW lies in Khyber Pakhtunkhwa, 21,725 MW in Gilgit-Baltistan, 6,450 MW in Azad Jammu & Kashmir and 7,291 MW in Punjab.

Small dam in District Karak

Within Khyber Pakhtunkhwa, 21% of the rural and 2% of the urban population is still not covered by drinking water and sanitation services. Overall, there is low agricultural and water productivity in the province with 57% losses in the field (due to conveyance, evaporation, system recharge and return flows). Water tables at different locations are dropping fast with excessive extraction and inadequate recharge. This has an impact not only on water availability, but also water quality due to arsenic contamination and salinity intrusion. The loss of water supplied to households is unquantified, but a rough estimate indicates 42% losses in the domestic sector, due to poor practices. Domestic requirements are almost completely met from groundwater resources. There is usually no control of the wasteful use of water due to a flat rate tariff system. Only in areas where drinking water is scarce are consumers more careful and efficient in water utilisation. Loss of water quantity and quality in the industrial sector is also undocumented but is speculated to be higher than in the domestic sector. Industries generally do not respect water efficient practices and quality control regulations.

Fruit orchard with wheat intercropping, District Charsadda

The forest area of Khyber Pakhtunkhwa under the management of the Forest Department is 841,517 ha. Of this, 7.6% (63,915 ha) are state-owned Reserved Forests, 29.7% (250,106 ha) are Guzara Forests owned either by community or private individuals and 62.7% (527,496 ha) are Protected Forests. In addition, the former Federally Administered Tribal Areas (FATA) has 529,282 ha managed by the Forest Department. It is believed that the natural forest in the province has deteriorated. Loss of forests has been directly attributed to the weakening of their watershed protection function in hilly areas, contributing to the severity of natural disasters including the 1992 and 2010 floods. Changes in forest cover and density are correlated with other environmental changes that may affect precipitation and runoff.

Forest in Chitral Gol, District Chitral

With a history of over sixty years of government-led support for water through several highly organised and well-staffed departments, the population is still suffering from issues related to poor water management. The planning and budgeting of water and related schemes is handled by designated departments and institutions. There is no holistic water resource assessment (supply and demand) and, therefore, no subsequent water management plans are currently prepared for integrated planning at any level.

One important reason for poor water management is the limited participation of the communities and beneficiaries in decision-making. Poor operation and maintenance of infrastructure schemes is a challenge. Traditionally, communities are seen only as the recipient of public services provided with tax-payers' money. Various examples in Pakistan and around the world suggest that formal and regulated community participation increases access to water and increases the likelihood of proper operation and maintenance of infrastructure schemes.

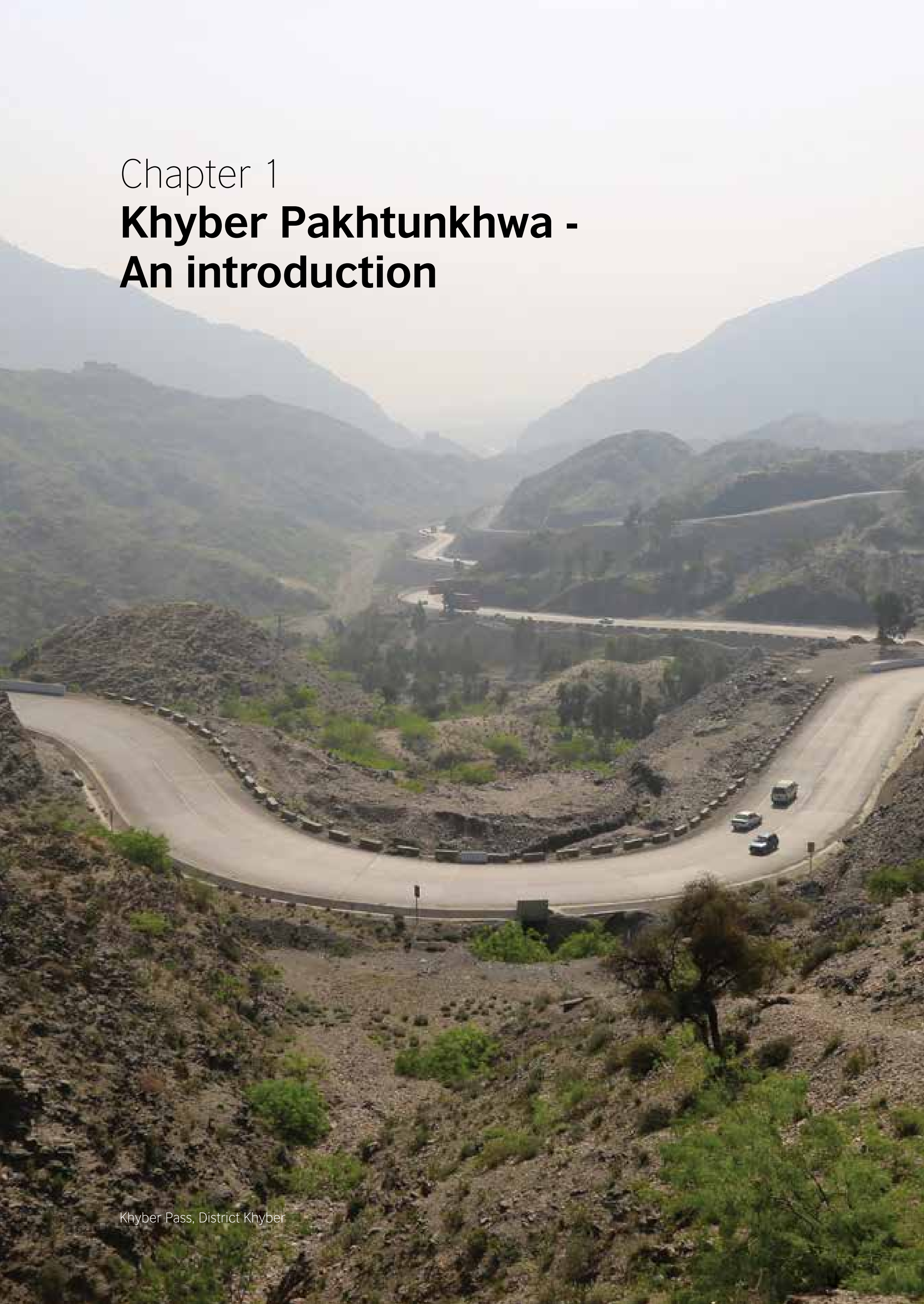
Land and water are the main natural and economic resources of the country, and the source of livelihood for a very large segment of the population. Substantial physical infrastructures are already in place for harvesting these resources. The National Water Policy, 2018 states that Pakistan's water must be a source of development, dignity, and prosperity for all citizens. Pakistan's commitment to Agenda 2030 and the Sustainable Development Goals obligates the sustainable management of water and sanitation for all, water use efficiency and integrated water resource management. Pakistan's economy is water-dependent with 60% of the population directly engaged in agriculture and livestock and 80% of the country's exports based on these sectors, including some products (mainly horticulture) coming from Khyber Pakhtunkhwa. Approximately 90% of surface and fresh groundwater resources are injected into agriculture. Therefore, Pakistan has a long-term interest in securing its water resources and improving efficiency in agriculture and domestic sectors. With a growing population, Pakistan is on the verge of being included on the list of water-stressed countries and, therefore, pro-active steps are needed to improve the situation.

The National Water Policy supports the concept of integrated management of water resources and suggests that the provinces develop their own water related strategies including Integrated Water Resource Management (IWRM). *"An IWRM strategy which can promote the coordinated development and management of water and land resources in a sustainable and equitable manner, as yet has not been achieved"*. Recognizing this, the province of Khyber Pakhtunkhwa has developed and notified an IWRM strategy in March 2020 which takes water as one shared finite economic entity. The strategy stands on four pillars and twelve priority areas. The four pillars already reaffirm a long-term visionary thinking with a focus on improved water balance, improved water governance, public private partnership, and enhanced citizens' participation.

Pakistan Vision 2025 states that *"Pakistan's ultimate aspiration is to see Pakistan among the 10 largest economies of the world by 2047, the centennial year of our independence".* This cannot be done unless our water resources are most productively utilized and water balance, that currently is too lopsided to feed agriculture with huge losses, are slightly more tilted to ensure access to safe and clean domestic water by population, for both women and men. We need a water economy in which losses and leakages are minimized in favour of access to water to a wider population and to cultivable lands.

Chapter 1

Khyber Pakhtunkhwa - An introduction



Khyber Pass, District Khyber

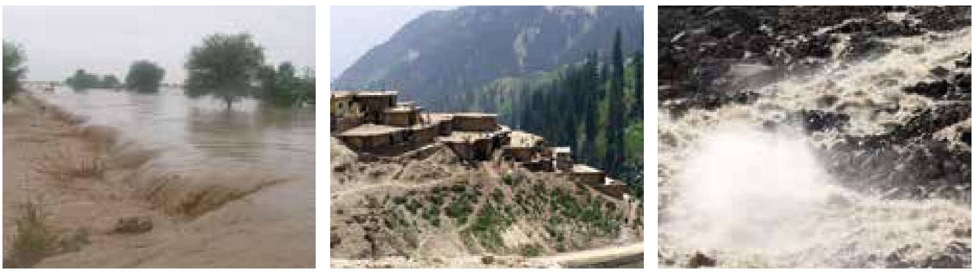
Chapter 1
Khyber Pakhtunkhwa- An introduction

Arjumand Nizami

The Khyber Pakhtunkhwa (KP) province of Pakistan lies in the Northwest of the country and was created in 1901 during the British rule, when it was separated from the Punjab province of the then British Empire. The famous Khyber Pass links the KP province with Afghanistan. Stretching North to South, the province is characterised by rich cultural heritage and landscape with forest clad mountains, fertile agricultural plains and rocky drylands and deserts. The hilly terrain in the North and East, with its snow-capped peaks and lush green valleys, is renowned for its beauty and has enormous potential for tourism. The landscape diversity is an opportunity but also increases exposure to vulnerability due to climate variability and change.

Cultural glimpses in districts Peshawar and Chitral

KP lies primarily on the Iranian plateau, at the junction of the Hindukush mountain slopes on the Eurasian plate and the Indus-watered hills of south-central Asia. The geography of KP is a profound blend of landscapes varying from Hindukush Himalaya mountains in the north to hot plains in the south. Districts along the Western border of Pakistan and Afghanistan are predominantly mountainous with two major climatic systems, the monsoon to the east and the Mediterranean towards the west with a dry and semi-dry climate. The province is faced with multi-hazards and frequent hydrometeorological disasters due to climate variability and extreme events.



Disaster risks and vulnerabilities in KP

KP has a high incidence of multi-dimensional poverty (GoP, 2017a). Among other factors, lack of access to water is a major driver of poverty and deprivation. Therefore, engaging in water sector development for improved access to water is a key driver to improve the well-being of the people.


Village communities in districts Chitral and Kohat

Population

In 2017, the total population of KP province was 35.524 million, living in 4.404 million households. The majority, 30.523 million, were living in the settled districts whilst 5.001 million were in the newly merged tribal districts and former frontier regions (FR). Out of the total population, 83.5% lived in rural areas (GoP, 2018a). The population of KP is increasing at an average of 2.65% per annum and will cross 51 million by 2030 and 89 million by 2050[1], if growth continues at current rates. Table 1.1 presents the demographic features of the province according to latest available figures.

Table 1.1 Population of KP province in 2017

Area	Male	Female	Total
Settled districts			
Rural	12,495,000	12,298,000	24,793,000
Urban	2,972,000	2,758,000	5,730,000
Sub total	**15,467,000**	**15,056,000**	**30,523,000**
Tribal districts			
Rural	2,482,000	2,378,000	4,860,000
Urban	74,000	67,000	141,000
Sub total	**2,556,000**	**2,445,000**	**5,001,000**
Total rural	**14,977,000**	**14,676,000**	**29,653,000**
Total urban	**3,046,000**	**2,825,000**	**5,871,000**
Grand total	**18,023,000**	**17,501,000**	**35,524,000**
Source: GoP, 2018a			

[1] Provisional summary results of 6th Population and Housing Census. Bureau of Statistics, Government of Pakistan.

Land-use

KP province is endowed with a geographical area of 12.89 million ha. The diversity of terrain from North to South results in very varied land use experiencing substantial seasonal variations. Land use data are available for 65% of the geographical area of the province. Out of the total reported geographical area, the cultivable area is 3.17 million ha (38%) of which 1.89 million ha (60%) is cultivated leaving a significant area (40%) of non-cultivated, barren land. Of the remaining area of the Province, 16% is covered by forests whilst 46% is unsuitable for cultivation. The area under various land uses in KP is detailed in Table 1.2.

Table 1.2. Area Statistics of KP province (million ha)

Type of area	Settled district	Tribal districts	Total
Geographical area	10.17	2.72	12.89
Land use in reported area	5.63	2.72	8.35
Cultivated area	1.63	0.26	1.89
Cultivable barren area	1.08	0.20	1.28
Forest area	1.26	0.07	1.33
Not available for cultivation	1.66	2.19	3.85
Source: GoP, 2018b; GoKP, 2019a			

Land holdings in KP are generally small and owners have very little risk-taking capacity. This makes overall land management very difficult, especially in the context of changing climate with frequent extreme events (Zulfiqar et al., 2019). In this scenario, adaptation to new, efficient, and innovative cultivation materials and techniques can be crucial.

Wheat fields in District Chitral

Livelihoods

Agriculture is the major source of livelihoods in the province, 80% of the workforce in rural areas being thus engaged – contributing to the provincial as well as the national economy. Agriculture contributes about 24% of the provincial Gross Domestic Product (GDP), accounts for half of the total employed labour force and is the largest source of foreign exchange earnings (GoP, 2019). The main factor limiting agricultural development in the province is water. Irrigation supplied through the government-managed canal system reaches only 34% of the total cultivated area, whilst the remaining 66% is either cultivated under rainfed conditions or barren (Khan, Khalil and Mohammad, 2019). A small area is also irrigated from the community managed irrigation channels. The total irrigated area of the province is much lower than the national average, which stands at 60.67% of all cultivable land (GoP 2014a). Most of the country's irrigated area is in Punjab.

Different livelihoods sources in KP

The performance of agriculture in the country during 2018-19 remained subdued, growing only by 0.85%, much lower than the target of 3.8% (GoP, 2019). The under performance of the agriculture sector was attributed to insufficient availability of irrigation water and a consequent drop in the cultivated area. Unchecked urbanization including the conversion of fertile irrigated agricultural land into building land for new townships is another serious problem that needs to be controlled though appropriate legislation. On average, 82% of all farmers own less than 2 ha land, indicating a high incidence of subsistence farming in the province (Zulfiqar et al., 2019). Livestock rearing is also an important component of the economy especially in rural areas. Livestock represent 58.9% of the agricultural economy and 11.2% of national GDP. This sector grew at 4% against the target of 3.8%.

Livestock grazing in District Haripur

Water resources

Nearly 40% of geographical area in KP is arid or semi-arid in nature with less than 500 mm rainfall (Table 1.3). This is lower than the national figure of approximately 75% of the land area falling in arid (less than 250 mm rainfall) and semi-arid (between 250-500 mm) regions (GoP, 1992). Within the arid and semi-arid region of the province lives 25.17% of the total population, largely depending on subsistence agriculture, livestock, wage labour, services, and remittances. This region is economically resource-poor with limited large-scale commercial agriculture and industrial activity.

Table 1.3. Rainfall, area and poulation of arid/semi-arid districts of KP province

No.	Districts	Annual average rainfall (mm)	Geographical area (million hactare)	Total population
1	Bannu	493	0.122	1,211,006
2	Chitral	422	1.485	447,362
3	DI Khan	319	0.732	1,695,688
5	Karak	455	0.337	706,299
6	Kurram	493	0.331	619,553
7	Lakki Marwat	440	0.316	902,541
8	Mohmand	310	0.230	466,984
9	North Waziristan	405	0.471	543,254
10	Orakzai	480	0.154	254,356
11	South Waziristan	387	0.662	679,185
12	Tank	390	0.168	428,274
13	Khyber[1]	505	0.337	986,973
	Total		**5.211**	**8,941,475**
	% of total geographical area of KP / population		**40%**	**25.17%**

[1] Note: District Khyber is just at the borderline of 500 mm rainfall and is, therefore, included in the calculations. Source: Nizami et al., 2020

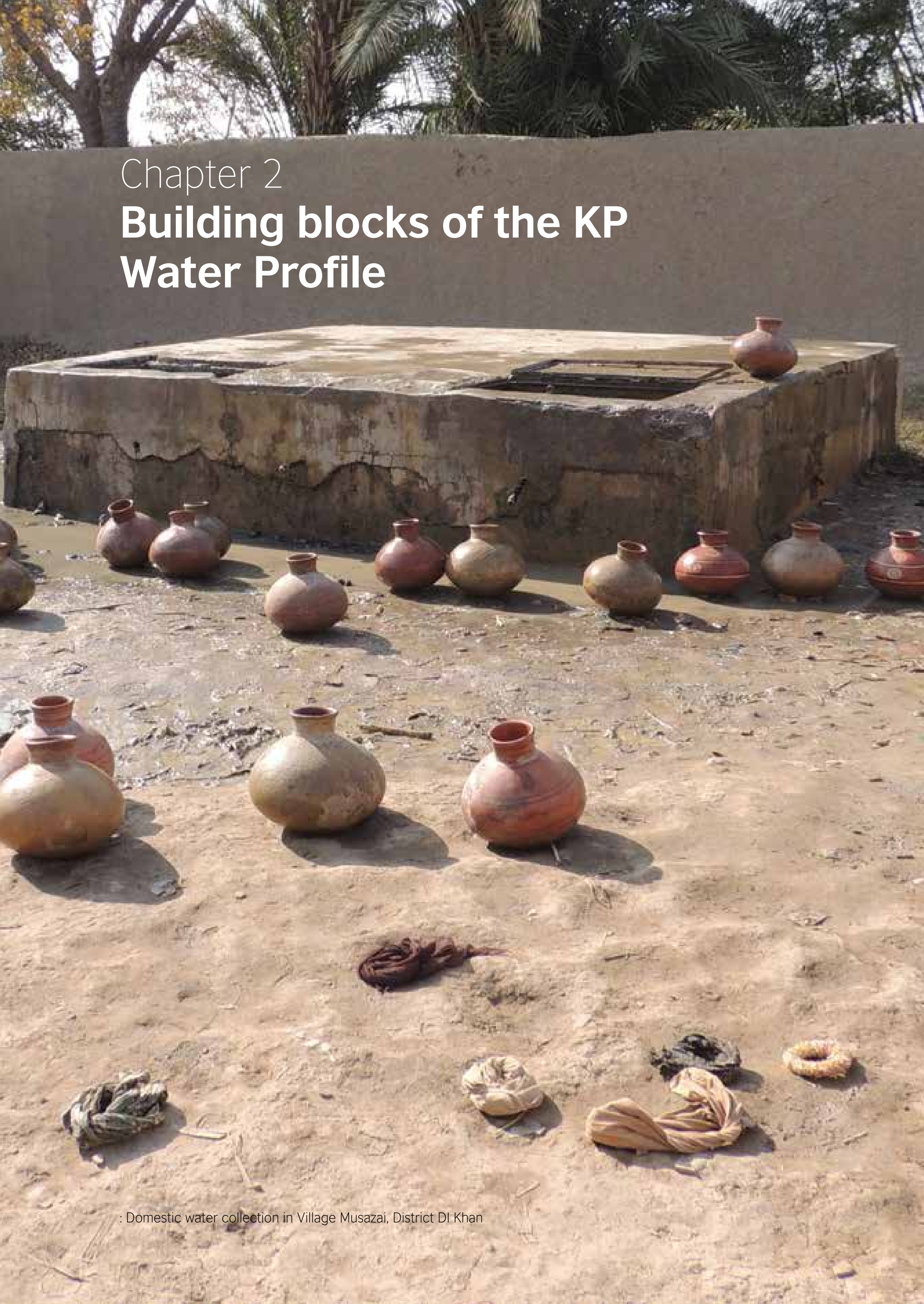
A large area of KP comprises highlands which are highly vulnerable to climate variability and change (Ali et al., 2014) and rich in water resources which play an important role in the regional hydrological cycle (Grumbine et al., 2014). The major and minor rivers that run through the province include the Indus, Kabul, Swat, Chitral, Kunhar, Siran, Panjkora, Bara, Kurram, Dor, Haroo, Gomal and Zhob. As stated earlier, land holding in KP is generally small and owners have very little risk-taking capacity. Innovative methods for efficient water management and conservation are very important in this scenario.

There are competing demands for water from various sectors, including, but not limited to, drinking water and sanitation, agriculture, irrigation, manufacturing and industry, environment and ecosystems, and hydropower. About 95% of the nation's available freshwater resources are reportedly utilized for agricultural purposes whilst a nominal proportion of 5% is used for domestic and industrial purposes (GoP, 2018b). Out of 2.28 million acres, government canals irrigate 1.247 million acres (55%), while the rest comes from civil canals, lift irrigation schemes, dug-wells, tube wells and other sources (Khan, 2019b). Groundwater abstraction through 37,117 tube wells and dug wells is estimated to the tune of 3.97 MAF (Khan, Khalil and Mohammad, 2019) of which 3.94 MAF is abstracted for agriculture. In addition, hill torrents provide 2.47 MAF and small dams provide 0.28 MAF. The water potential of hill torrents is not fully harnessed. Thus, the available irrigation water from the Indus River System Authority (IRSA), civil canals, groundwater abstraction and other sources including hill torrents and small dams, is 14.66 MAF. The province still lacks water to fulfil all its agricultural needs and requires more investment in the construction of new infrastructure to increase the area under irrigation. This may include, for instance, an expansion of irrigation channel networks and the construction of small, medium, and large storage reservoirs.


Water towers of KP – Highlands of District Chitral

Chapter 2

Building blocks of the KP Water Profile



: Domestic water collection in Village Musazai, District DI Khan

Chapter 2
Building blocks of the KP Water Profile

Munawar Khan Khattak
Jawad Ali

The KP Water Profile described in this document emerged from a combination of primary data and meta-analysis of several position papers and sub sector status reports prepared for the development of the Integrated Water Resource Management (IWRM) strategy of the KP province. In addition, this work has benefited from several recent research papers and studies.

Primary data

The following tools were used for primary data collection.

Agriculture: Interviews with experts including members of faculties of the University of Agriculture Peshawar and staff of the Agriculture Extension, On Farm Water Management and Agriculture Research Departments. Two comprehensive workshops held at the Bureau of Agriculture Information and attended by over 150 officials of the Agriculture Extension, Research and On-Farm Water Management Departments and farmers served for the compilation of the farming system of the individual districts.

Climate change: Decadal climate scenarios up to 2040 were developed with data available from the Pakistan Meteorological Department (PMD, 1981-2020) based on the real time climate data and CMIP5 models of the International Panel on Climate Change (IPCC). These data were also used for establishing the latest risk profiling of the districts and agro-ecological zones.

Drinking water: Key informant interviews were conducted with the concerned government officials, subject specialists and staff of civil society organizations who have expertise in water and sanitation for mitigating the data gaps and the triangulation of available information.

Groundwater: The main challenge in KP water profiling was a complete lack of data for some districts. No prior study was available on groundwater in this area. In order to fill this data gap, a fresh study was conducted by Pakistan Council of Research on Water Resources (PCRWR) and Helvetas. The study results have been used in this book.

Energy and Hydropower: Several officials of the Energy and Hydropower Department were interviewed to fill data gaps on the progress of the hydropower sector in the province. Consultations were held among expert groups, including cross-checking findings with the concerned departments.

Industries: More than 100 individual interviews were conducted with respondents from government offices, independent water experts, owners, and employees of private entities, water users, Tehsil Municipal Administrations (TMAs) and officials of the KP Economic Zones Management and Development Company. Site visits, where needed, were conducted to collect data on the sources of water and water pollution.

Water users and their associations: Primary data were collected through a series of discussions and interviews with community activists, practitioners of community development and other experts on institutional development in various districts.

Secondary data

The main sources of secondary data included available literature and data files held in water sub-sector departments:

- Collaborative analysis of peer reviewed papers where available (mainly on water contamination, forestry, agriculture, climate change and irrigation), reports, and publications by international agencies.
- Government sources: Data available within the respective departments, published reports, legally notified documents, policies, Acts, and websites of respective line departments.
- Analysis of funds allocation and expenditures data over the last ten years from the Planning and Development Department, Government of KP, to ascertain priorities and trends.

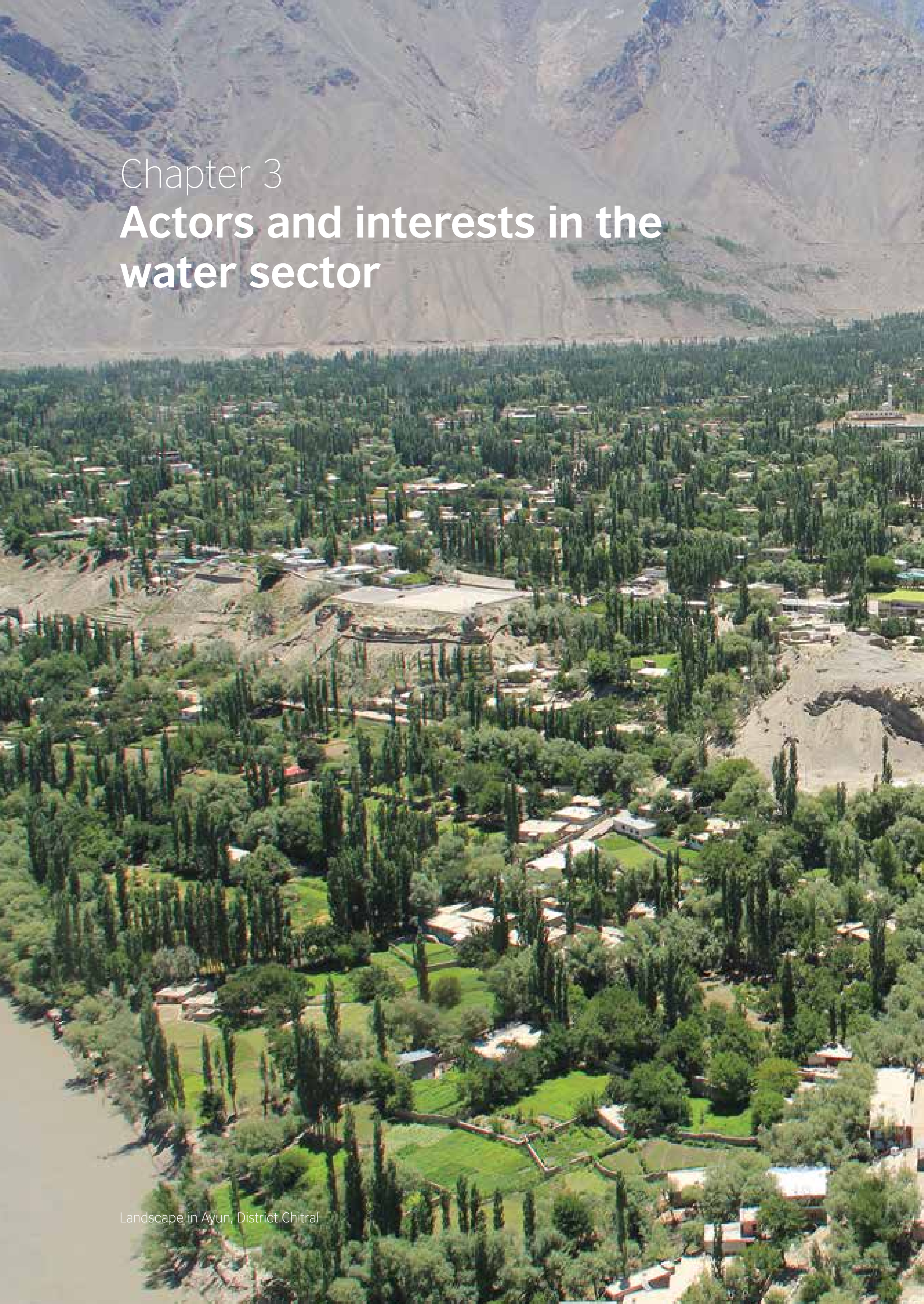
Data challenges in the water sector

The KP IWRM strategy development process during 2018-2020 led to the revelation that alongside data deficiency, there are data management challenges. Even senior in-service and retired officers involved in writing sector papers for the IWRM strategy faced these challenges and readily recognized the issue. They faced difficulty in collecting scattered data from the departments in which they had served many years, as well as in determining the reliability of, and authenticating, the available data.

The officials writing the sector papers also realized that data paucity and deficiency is a relatively minor issue compared to problems over the reliability and systematic organization of data. Extensive primary data are available in various sectors and subsectors, but these data need to be systematised to enhance accessibility and reliability. Most of the public sector websites are hardly updated for extended periods. At times, the departments themselves relied on other sources for data related to KP, such as reports produced by various UN agencies, the World Bank, and other international organizations. These documents may have used multiple sources of data and references for meta-analysis and have thus served as a temporary solution for mitigating data gaps.

Authors of the sector papers authenticated available data with other sources in addition to collecting primary data where necessary. The preparation of the IWRM sub sector papers and KP water profile, therefore, served as an excellent opportunity to raise internal awareness on data gaps and the need to introduce urgent measures to become better organised. This work served an occasion to consolidate and systematically manage some of the most important scattered data and to supplement these figures with primary data for relevant sectoral reports and for future reference.

Chapter 3
Actors and interests in the water sector



Landscape in Ayun, District Chitral

Chapter 3
Actors and interests in the water sector

Irshad Ali Mian
Syed Nadeem Hussain Bukhari

Recognizing that water management is an integrated development issue, the actors' map of water sector is somewhat different from a conventional actors' map narrowly focusing only within the sector. Owing to its multiple uses and competition for access, and the way it is valued as a resource, water resource management concerns multiple stakeholders with various interests and influences. An active stakeholders' participation creates a dynamic and enabling environment for the sector at all levels.

Some of the major actors and stakeholders are briefly introduced in this chapter.

Federal governing institutions

Federal Ministry of Water Resources, Government of Pakistan https://mowr.gov.pk

This Ministry was founded in 2017 following the dissolving of the Ministry of Water and Power and merging the Power Division into the then Ministry of Petroleum and Natural Resources, which was converted into the Ministry of Energy. The functions of the Ministry include matters relating to the development of water resources of the country, governing the Indus Water Treaty, 1960 and the Indus Basin Works, managing the Water and Power Development Authority (WAPDA), the Institute of Engineers Pakistan (IEP) and the Indus River System Authority (IRSA), exercising administrative control of the Tube-well Construction Company, liaising with international water related institutions, promoting special studies in water sector, and coordinating on trans-border water issues.

Indus River System Authority (IRSA), Ministry of Water Resources, Government of Pakistan http://mowr.gov.pk/index.php/irsa/

IRSA is guided by the Water Apportionment Accord (WAA) signed amongst the Provinces on 16 March 1991 and approved by the Council of Common Interests (CCI) on 21 March 1991. IRSA was established under clause 13 of the WAA vide Act No. XXII of 1992. It is a Federal authority regulating and monitoring the distribution of water sources of the Indus River in keeping with the Accord amongst the provinces and providing connected and ancillary services to the Accord. IRSA mediates the misuse of water among the provinces and reserves the authority to approve projects involving major infrastructural investment in the provinces.

Water and Power Development Authority (WAPDA), Ministry of Water Resources, Government of Pakistan http://mowr.gov.pk/index.php/wapda/

WAPDA was established through an Act of Parliament in 1958 as an autonomous and statutory body under the administrative control of the Federal government. It is guided by the Pakistan Water and Power Development Authority Act, 1958. WAPDA comprises a Chairman and three Members (Water, Power and Finance). Following a review in 2007, WAPDA's mandate is now the development of water and hydropower resources in an efficient manner. It conducts large scale energy projects, implemented after receiving agreement from the concerned provinces.

Provincial governing actors (KP)

Irrigation Department – KP http://www.irrigation.gkp.pk/about.php

The Irrigation Department is mandated to look after and manage the physical infrastructure as well as to introduce system design and management practices. The Secretary of the Department is supported by a Planning and Monitoring Cell (PMC). The PMC prepares the draft Annual Development Programme and Public Sector Development Plan. It is also responsible for liaison with the Federal government and donor agencies regarding new schemes and monitors progress in the implementation of existing portfolios. The execution of the water sector schemes, and their regular operations, are carried out by the attached departments. There are three attached departments under the Irrigation Department, each headed by their respective Chief Engineer. The attached departments include operation and maintenance wings North & South, and Small Dams Organisation. The Irrigation Department is governed by the Canal and Drainage Act, 1873 (Act VIII of 1873); the Minor Canal Act, 1905 is also applicable.

On-Farm Water Management Directorate, Agriculture department, KP http://ofwm.kp.gov.pk/page/introduction

The main objectives of the OFWM are the organisation and establishment of water users' associations to participate with the government on a cost sharing basis; and the enhancement of agricultural production through optimal use of irrigation water and improved water management and agronomic practices. This is accomplished by providing training to the members of the water users associations and OFWM staff (on matters such as agriculture productivity and the operation and maintenance of irrigation system). The main functions of the OFWM include conducting feasibility studies of potential projects, planning water management strategies for the conservation of scarce water resources, and planning for maximum involvement of the beneficiaries in the operation and maintenance of the secondary irrigation system.

Water and Sanitation Services Companies http://wsspeshawar.org.pk/vision/

The Water and Sanitation Services Companies (WSSCs) are newly established urban utilities owned by the government of KP. These companies have become the first in Pakistan to deliver urban water and sanitation services to the users. As corporate governed bodies, they are autonomous and are expected to be professionally managed. So far eight companies have been established. For example, WSS-Peshawar comprises 45 urban and 22 semi-urban union councils. Its vision is to bring the water and sanitation services of Peshawar city on a par with international standards. Its purpose is to enhance the sector capacity in the provision of water, sanitation, environmental and social awareness services to provide effectiveness and sustainability towards improving the health of the people of Peshawar and raising their living standards.

Public Health and Engineer Department (PHED) KP http://www.phedkp.gov.pk/

The PHED was established in 1974 to provide clean drinking water, hygiene facilities and a healthy environment to the public. The Department is divided into Northern and Southern units for administrative purposes. Its objectives include comprehensive planning; ensuring clean drinking water schemes and sewerage system; maintaining pipes and improved machinery for a clean drinking water and sewerage system; testing and research of hygiene-related schemes; continuous data collection and statistical analysis to ensure the provision of quality water; and capacity building of staff engaged in engineering. The PHED operates according to the legal provision provided in the KP Rural Area Drinking Water Supply Scheme Act, 1985 (VI), whilst the KP Drinking Water Policy, 2015 provides policy guidelines. The PHED only levies water connection charges at a flat rate; no fee is charged by the quantity of water used. It largely depends on groundwater resources to provide drinking water to domestic clients.

Energy and Power Department KP http://energy_power.kp.gov.pk/

The Energy and Power Department is responsible for hydropower, oil and gas. This Department aims at providing low-cost power generation; encouraging private sector investment through full cost recovery and attractive rates of return; ensuring the fast track and transparent development of power projects; encouraging and ensuring participation of investors in the development and implementation of hydropower projects; ensuring participation, development and welfare of all stakeholders and providing green energy. Activities of the Energy and Power Department are regulated through the Energy Development Organization Act, 1993. The Department has no direct role pertaining to the regulation of water resources.

Environment Protection Agency (EPA) KP http://epa.kp.gov.pk/

The EPA administers and implements the EPA Act, its rules and regulations. These include: Initial Environmental Examination (IEE)/Environmental Impact Assessments (EIA) and the preparation of procedures and guidelines; the preparation, revision and enforcement of Environmental Quality Standards (EQS); the establishment and maintenance of laboratories; the certification of laboratories for conducting tests and analysis; the provision of assistance to local councils/authorities and government agencies in the execution of projects; the establishment of a system for surveys, monitoring, examination and inspection to combat pollution; the training of government functionaries and industrial management; the provision of information and education to the public on environmental issues; and the annual publication of the state of the environment report. The EPA is tasked to collect qualitative and quantitative data on air, soil, water, industrial/municipal and traffic emissions; and to undertake research and development activities to promote the environment. The legal provisions for the EPA are the KP Environmental Protection Act, 2014 and the Environmental Protection Tribunal Rules, 2016.

Tehsil Municipal Administration (TMA) http://local_government.kp.gov.pk/

Various district-based actors (e.g., district administrations) may influence local level water decisions, financing, dispute management and advocacy in various areas. Often their role is under-estimated in the governance of the water sector, and they are excluded from the list of water actors. An example is the TMA. TMAs are mandated to provide "municipal services" including water supply, sanitation, conservancy, removal and disposal of refuse, garbage, sewer, or storm water, solid or liquid waste, drainage, and public toilets. Their responsibilities also include the development of water resources, construction and maintenance of water supply and sanitation projects. TMAs are further empowered to check water way encroachments. The legal provisions for TMAs in these matters are the KP Local Government Act 2013. No. XXVIII, 2013 and the KP Tehsil and Town Municipal Administration Rules of Business, 2015.

Research institutions and think tanks

Research institutions and think tanks do not have a direct stake in water, yet they can indirectly influence water related dynamics with their specialised work in water sector. These are mostly national and international water research institutions funded / recognised by the government.

An example at national level with provincial presence is the Pakistan Council of Research on Water Resources (PCRWR) - http://www.pcrwr.gov.pk/. PCRWR was established in 1964 and works as a corporate body as set out in the PCRWR Act, 2007, under the Ministry of Science and Technology. The Council is managed by a Board of Governors, the Chairman, and the Executive Committee. Since its inception, the PCRWR has played its role as a national research organisation by undertaking and promoting research in various disciplines of the water sector. Specifically, these include irrigation, drainage, surface and groundwater management, groundwater recharge, watershed management, desertification control, rainwater harvesting, water quality assessment and monitoring, water conservation and the development of water quality improvement technologies.

Civil society organisations

Water users' associations and community-based institutions are also included in this category. Most resource management decisions in Pakistan are dominated by technical aspects rather than the perspective of end-users and managers. So far, community institutions have been left out of the water sector equation. However, one example of efficient local water management is provided by the 17 Water Users' Associations (WUAs) in Chitral, Tank, DI Khan and Karak. The members meet regularly and resolve community conflicts effectively. They also advocate for their rights, obligations, and problems[2]. These organisations are playing a significant role in the operation and maintenance of all the schemes that they have implemented with donor funds under a tripartite arrangement with the government and the project. The WUAs are government-registered and can perform their role independently.

WUAs are also organised by the government On-Farm Water Management Department for playing a role in improved on-farm water governance. In the usual scenario, however, water users are quite forgotten as water stakeholders, and it is not considered obligatory to organise or consult them in major decisions in the sector.

National, provincial, and local NGOs as well as International NGOs are engaged in multi-sector development projects. Some of them have a specific interest in the water sector, especially in domestic use and the management of water.

Media related actors serve to create a link between multiple actors with common interests and an open door to all voices. Notably, there are several news articles in the print media that provoked constructive debate on the management and governance of the water sector in Pakistan. Some of these articles have also been referenced in this book.

Citizens

This group of actors has a highly pluralistic character, including a range of domestic users, youth, tourists, women, and men. In recent years, the level of their awareness has much improved, thanks to media campaigns on water conservation and policy moves at national and provincial levels. Their behaviour and (lack of) responsible water use may have a direct impact on the future of water resources. Strong citizens with responsible behaviour have a high influence on water sector decisions.

[2] These WUAs were organized under the Water for Livelihood project financed by the Swiss Agency for Development Cooperation (SDC) since 2011 with the help of active mobilisation by local NGO partners in the respective districts.

Private sector

The private sector includes commercial companies, supply chain actors and corporates which consume water in their manufacturing processes. The private sector does not yet have recognition as a partner in the water sector. Astute company owners are always concerned about the sustainability of their supply chains and production processes. This sustainability is closely linked with efficient use of water resources as a factor of production. A proper regulatory framework can ensure that this behaviour is obligatory and not voluntary by the companies.

The private sector may also include actors with expertise in technology development. Their role is not yet fully integrated into the efficient use of water resources. These actors are often not perceived or recognised as relevant actors and are excluded from dialogues and decision making in the water sector. Yet their actions and knowledge have potential relevance for the future management of water resources.

This brief stakeholder analysis suggests that currently water users and their collectives, especially women and small farmers / self-operators, are forgotten players whilst the major power play is more between large landowners and authorities.

The active participation of stakeholders creates an enabling environment for the sector. However, public debate among stakeholders on water issues is weak. Structured coordination has been proposed in the National Water Policy and provincial policy chapters. So far, however, these mechanisms are not yet fully implemented and remain ad hoc in nature. Politicians and decision makers have little access to first-hand knowledge of local water management/distribution systems and issues, particularly the dimension of social tensions in areas outside the Indus basin canal irrigation.

The government overall remains an actor that is most burdened with high expectations for ensuring access to water for all purposes. There are hardly any obligations on users (communities, farmers, citizens, industries). One reason is a complete lack of the concept of water pricing and the involvement of private sector services. Another important element requiring strengthening is research to inform decision-making and determine tangible entry points (such as technical solutions) that increase the level of obligations to water users.

Chapter 4

Climate change and water

Gated structure in Rudh Kohi irrigation management, DI Khan

Chapter 4
Climate change and water

Muhammad Hanif
Arjumand Nizami
Mohammad Akmal
Rizwan Ahmad

Several studies have identified the effects of climate change on water, showing that such effects differ across different regions of the country (Tubiello and Fischer, 2006; Nelson et al., 2009; Orlowsky et al., 2017). Water and agriculture are highly sensitive to climatic conditions and are directly affected by climate change. There is a close relationship between the two. It is, therefore, very important to understand climate change trends for longer term planning and preparedness. The climate baseline provided in this chapter has benefited from existing knowledge and most recent studies on environment, climate change and Disaster Risk Reduction (DRR) trends in KP. This latest work on climate trends is founded on the real time climate data (mainly rainfall and temperature) available with the Pakistan Meteorological Department (PMD) in the KP province.

Climate change is manifesting itself at regional and local levels through its biological production impacts and overall economic, social, political, and scientific consequences. Globally, Pakistan is included in the list of countries most vulnerable to the impacts of climate change (Eckstein et al., 2020). These impacts are already threatening the security of livelihoods and assets of the country's people. Nevertheless, using knowledge about changing climate trends and land suitability, threats can be transformed into opportunities. Pakistan is ecologically diverse and the sixth most populated country of the world with 5.8% growth rate[3]. The country has a predominantly agrarian economy contributing to over 21% of GDP and employing 45% of the total labour force with a major export income (GoP, 2010). Climate change exacerbated by local human practices poses an additional pressure on crucial and limited resources such as water and land. The most critical climate change factor is aridity combined with the dependence on a single river system – the Indus – which supports the biggest irrigation system of the world (GoP, 2015; Chaudhry, 2017).

It is noted that rainfall concentration has shifted some 80-100 km from East to West (Figure 4.1), further into KP province during summer/monsoon season. This may have economic implications for the farmers living in the areas affected and for the planners of Disaster Risk Management (DRM) and water management.

[3] http://data.worldbank.org/country/pakistan and http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS (websites accessed on 20-02-2020)

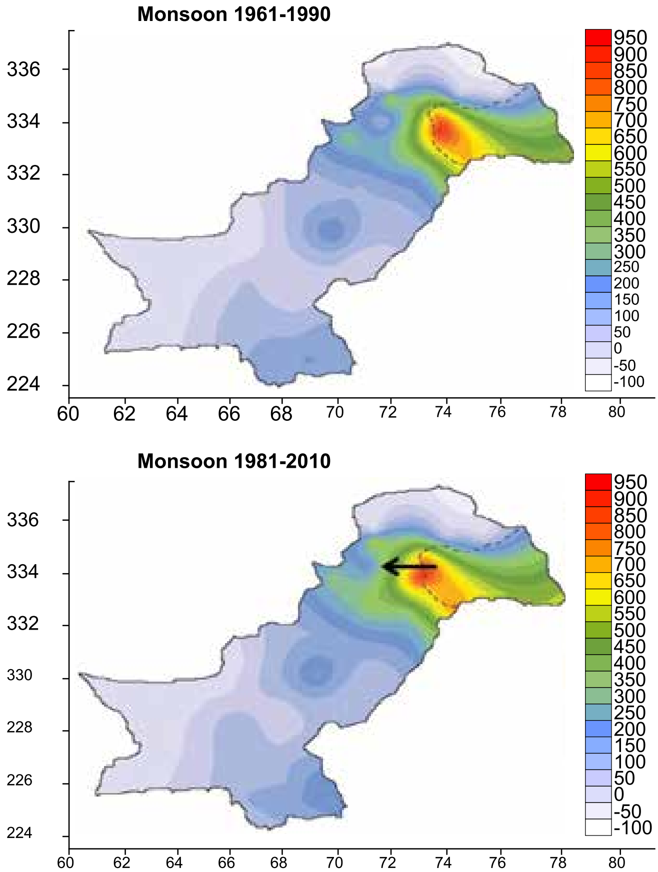


Figure 4.1. Monsoon shift in Pakistan 1981-2010. Source: Hanif et al., 2013

KP province demonstrates strong indicators of vulnerability to climate change due to the diverse agroecology and landforms but also because of changing temperature and precipitation regimes, which are inevitably significant for agriculture (Nizami et al., 2010). These shifting trends are impacting farming systems in the province in a significant manner. Climate variability and change manifest themselves in an increased frequency of hazards with negative impacts on crop yields. Fortunately, in KP province this realization already prevails among various stakeholders including the farmers. The level of response capacity, however, varies among stakeholders with limited preparedness for dealing with a multiplicity of risks. In terms of precipitation, KP province has generally remained fortunate regarding the distribution of precipitation when compared to other provinces. The annual rainfall for most of the province has been over 600 mm, serving as an important resource to feed Pakistan's river system (Figure 4.2). Yet just as the way rainfall patterns are shifting in the region and the country, the situation in KP is also changing. These changes need to be ascertained and their impact on water resources and other related sectors (such as agriculture) understood for early preparedness and decision making.

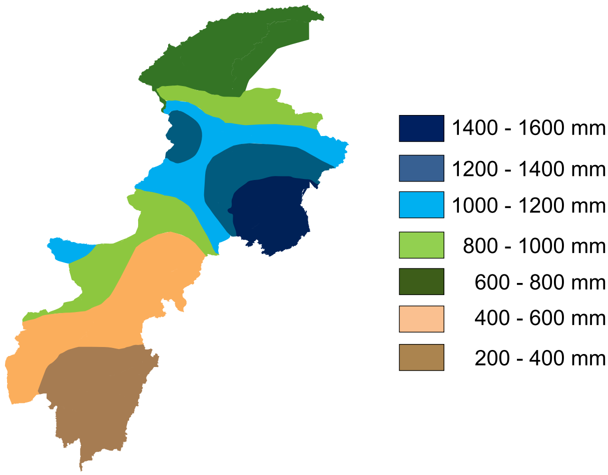


Figure 4.2. Average annual rainfall (1981-2010)

4.1 Temperature trends and scenarios

Generally, KP province is divided into three geographical regions: Central, South, and North (Figure 4.3). Based on this regional logic, average trends were analysed using decadal temperature scenarios for all the districts falling within these regions.

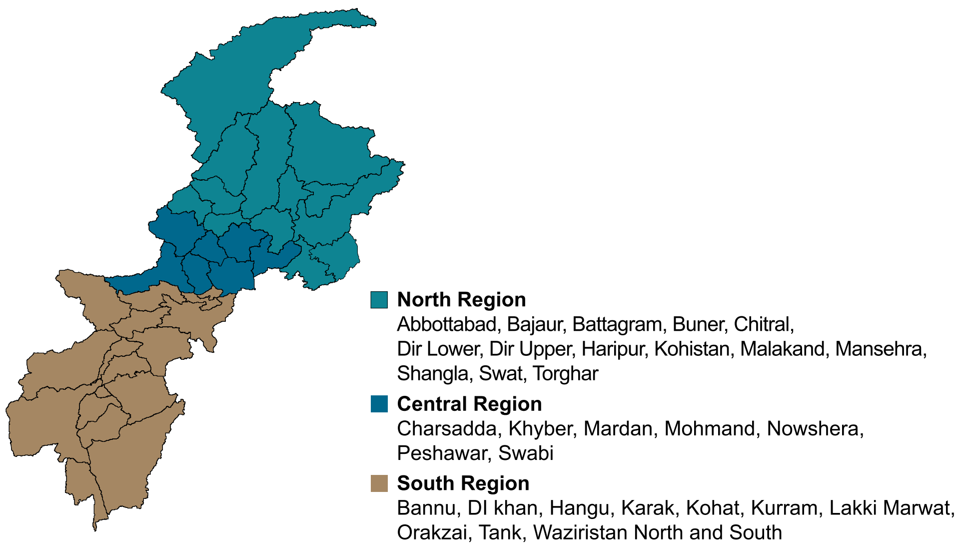


Figure 4.3. Geographical regions of KP province for temperature analysis

Considering temperature and rainfall, the months of the year have been divided into four seasons as follows:

a) **Winter**: December, January, February
b) **Spring:** March, April, May

- **c) Summer:** June, July, August, September
- **d) Autumn:** October, November

The regional analysis of temperature trends and scenarios presents a highly noticeable regional change in temperature from the base average temperature of 1981-2010. In all seasons, day and night temperatures will increase, except winters in the North where night temperature will slightly decrease (Figure 4.4). Overall, an average increase in temperature in the North (mountain areas) is the highest (1.9°C) closely followed by the Centre (1.8°C) and the South with 1.6°C, where the South is already zone of excessive heat (Figure 4.5). The changing trends of temperature clearly support to extend the wheat crop in northern region and to initiate cotton crop in the southern region through awareness in the local communities.

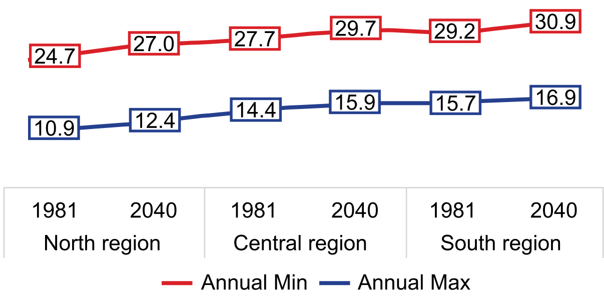


Figure 4.4. Annual average temperature in three geographical zones 1981 to 2040

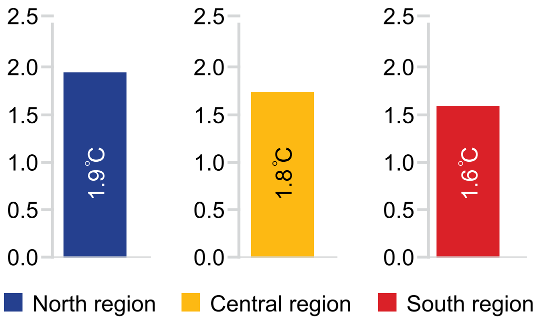


Figure 4.5. Annual average increase in temperature in three geographical zones 1981 to 2040

In summary, day and night temperatures in all seasons are increasing. Night temperatures are increasing at a lower rate by comparison with days, which are warming faster. This, coupled with a rise in both maximum and minimum temperatures in spring, may have disaster implications in the North. The most dangerous glaciers may need to be identified for potential damage assessment and for critical observation regarding early warning of the risk of glacial lake outburst floods (GLOF). Spring temperature is increasing at a very high rate followed by summer. Observations of temperature trends in the

North are crucial concerning glacial activity; when this combines with the late occurrence of snowfall, the likelihood of disasters becomes very high. Regulating water flow in the North together with effective DRR measures to avoid major overflows and mitigate the effect of heavy rainfall (which is also increasing in the North during spring and summer) must be given high priority using all possible biological and structural means.

4.2 Precipitation trends in KP based on climate scenarios

Three distinct regions emerge from decadal precipitation scenarios conducted for all the individual districts. These three precipitation regions were classified based on annual average precipitation, namely low (below 600 mm), medium (less than 1000 mm) and high (above 1000 mm). This classification is shown in Table 4.1 and Figure 4.6.

Table 4.1. Projected precipitation within KP province in 2040 (mm per year)

Low precipitation region	Medium precipitation region	High precipitation region
<600 mm	600-1000 mm	>1000 mm
Peshawar, Charsadda, Khyber, Kohat, Hangu, Kurram (lower), Karak, Bannu, Lakki Marwat, DI Khan, Tank, Chitral, Mohmand, Orakzai, North and South Waziristan	Swat, Malakand, Kurram (upper), Nowshera, Mardan, Swabi, Bajaur, Kohistan, Mansehra (North), Shangla	Swat (Lower), Buner, Dir (Lower and Upper), Haripur, Kala Dhaka, Abbottabad, Mansehra (South), Battagram

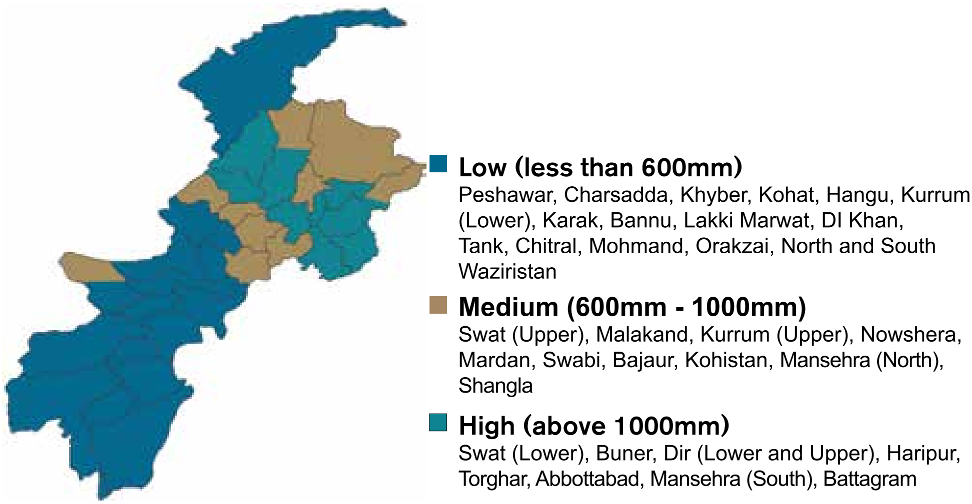


Figure 4.6. Precipitation regions of KP province forecasted for 2040

Overall, 18% of the districts in KP province are predicted to experience a diminishing annual rainfall/precipitation by the year 2040 whereas the precipitation in the remaining districts (82%) will either remain stable or will increase. This is further described below by regional and seasonal changes within KP province.

4.2.1 Regional change scenarios and implications

Table 4.2 provides the likely scenario of shifting precipitation patterns up to 2040 within and across the three precipitation regions. According to the map shown in Figure 4.6, most of the Southern and Central districts of KP province fall in the low precipitation region whilst most of the North has medium and high precipitation.

Table 4.2. Shifting patterns of precipitation in KP province 2010-2040

2010	2040
49% districts fall in low precipitation zone	46% districts fall in low precipitation zone
28% districts fall in medium precipitation zone	26% districts fall in medium precipitation zone
23% districts fall in high precipitation zone	28% districts fall in high precipitation zone

Hence there has been slight shift in terms of districts receiving lower or higher precipitation. Figure 4.7 describes the changes from the baseline period of 1981-2010 up to 2040.

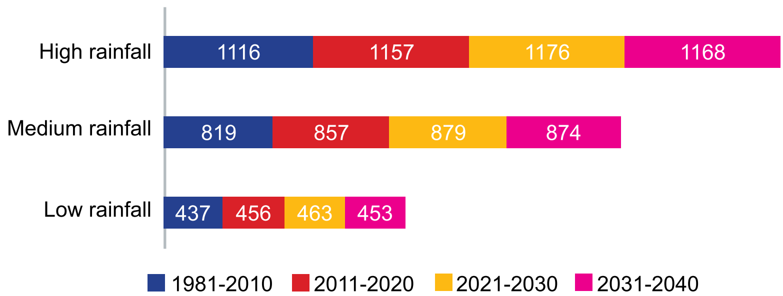


Figure 4.7 Average annual precipitation (mm) 1981-2040 in three regions of KP province

Low precipitation region

In this region, between 68-75% of annual precipitation occurs during the spring and summer; this is expected to increase in the period up to 2040. 21-26% of rain fall in winter, this is likely to decline up to 2040. The remaining 4-6% of rain received during the autumn is also likely to decline.

Implications

a. The low precipitation region will face a drastic water scarcity during the autumn and winter. Autumn and early winter is a crucial period for sowing wheat, meaning that wheat cultivation will be severely affected in the rainfed areas. In these districts, priority must be given to financial planning for water storage through small dams and high efficiency irrigation systems.

b. There is a high need in this region to work with farmers to adopt water efficient crop management as well as ways and means to predict and manage droughts. Strong measures to conserve summer moisture may help crops withstand autumn dry spells.
c. Historically there is a risk of intense, heavy rain showers and hailstorms in spring when the wheat harvest takes place.
d. The region will face an acute risk of smog due to increased winter temperatures and low rainfall.

Medium precipitation region

Between 72-79% of annual precipitation occurs during spring and summer and is likely to increase in the period up to 2040. The 22-27% of annual rain falling in winter will decline, as will the 5-6% falling in autumn.

Implications

a. The medium precipitation region is safe for the winter sowing of crops.
b. There will be major water scarcity for autumn cropping; special measures such as summer moisture conservation may help address the acute shortage of water.
c. Horticulture (fruit production) will be severely affected due to intense rains during flowering and fruiting periods.
d. This region has a medium risk of flash floods and landslides in hilly areas.
e. Historically, there is a risk of intense rain in spring at the time of wheat harvesting.
f. The districts of Mardan and Shangla are shifting to the high precipitation zone, which may be an opportunity but also has potential disaster implications which require structural and non-structural preparedness.

High precipitation region

Between 71-76% of precipitation occurs during spring and summer and is expected to increase in the period up to 2040. The 19-22% of annual precipitation falling in winter will decline, as will the 5-7% falling in autumn.

Implications

a. The high precipitation region is safe for the autumn and winter sowing of crops.
b. Horticulture (fruit production) will be severely affected due to intense rains during flowering and fruiting periods.
c. This region has a medium risk of flash floods and landslides in hilly areas.
d. Historically, there is a risk of intense rain in spring at the time of wheat harvesting.
e. The trend of snowfall in this region is increasingly shifting towards the spring. However, exceptionally this region may also experience unprecedented early snowfall events.

Snow concentration in future

In the high-altitude region, most of the precipitation occurs in the form of snow. Climate assessment suggests that maximum snowfall is shifting towards the spring. This is based on the overall pattern of the cryosphere in the Hindukush Himalayas (HKH) region of Pakistan. Temporal and spatial distribution of snow in the provinces of KP, Gilgit-Baltistan (GB) and Azad Jammu and Kashmir (AJK) follows an almost uniform overlay, but the amount may differ according to the elevation, aspect, and orientation of the landscape. Since the systems producing winter snow move from West to East, the snow cover over West-facing mountainous slopes has been higher than Eastern-facing slopes. In general, the frequency and amount of snow has gradually decreased in the valleys over the last two decades, with minimal snowfall now observed up to 2,500 m above sea level (asl) in GB, KP and AJK provinces.

4.2.2 Seasonal changes and implications

As stated earlier, the precipitation in 82% of the districts will remain stable or increase. However, the seasonal variation and shifts from previous patterns have significant implications regarding water availability for prime needs such as agriculture. Table 4.3 shows the seasonal changes and implications.

Table 4.3. Implication of seasonal changes in precipitation

Change	Implications
Winter precipitation By 2040, 85% districts will receive on average 20% less rainfall than the amount received today.	This change may result in acute water shortage in the next four decades. Prolonged drought during autumn and winter may result in the drying of springs and declining groundwater recharge. Agricultural production may resort to a greater reliance on pumped groundwater; this will only further deteriorate the situation if nothing is changed regarding water management and the utilisation of available moisture from the limited rainfall. Snowfall on the other hand will decline heavily during the early peak winter months of December and January. There is a likelihood of late snowfall in February, whilst exceptional early snowfall events in November cannot be ruled out.
Spring precipitation Except 13% of districts, all others will see an annual increase in spring precipitation by the year 2040. In addition, spring snowfall in mountain regions will increase the overall amount of precipitation.	An important warning is the increased tendency of torrential rainfall and a risk of hydrometeorological disasters during spring. In high-altitude regions, a major shift in snowfall towards spring may result in rapid melting during later months when the temperature rises fast, and the snow may not have solidified strongly.
Summer precipitation An overall increase of 14% is noted in the summer rainfall in KP province.	High altitude areas are likely to face the risk of flash floods or GLOF, with river over-flow during the early summer due to fast melting snow. In later decades (2030 onwards) reduced river flow may be noted since the water reserves derived from snow will shrink and contribute less to the rivers.

Autumn precipitation 19-34% of precipitation received is expected to decline in most (92%) districts of KP province by 2040.	As in the case of winter, autumn precipitation trends are highly worrying. October crop sowing is likely to be drastically affected in rainfed areas, especially if soil moisture from summer has not been conserved in some way.

In a nutshell, the overall proportion of annual precipitation in KP province is reducing in autumn and winter and concentrating in spring and summer. This means that the province must take highly effective rainwater harvesting measures for local use to avoid dependence on canals extracted from rivers or on groundwater (both resources being expected to diminish due to reducing rainfall and increasing temperature). A ground coverage of critical watersheds with trees or some other form of perennial vegetative cover is also highly necessary to regulate rainwater flows and quality. Furthermore, the changed precipitation pattern has serious implications for agriculture. Training and extension advice to farmers is critical to support them in adapting to this change. The first step towards achieving this is training and preparedness of extension staff, using appropriate language that can be understood by extension agents and farmers alike.

4.3 Interpreting precipitation and temperature trends

Precipitation and temperature trends for the three geographical regions of KP have different implications for various sectors and planners need to be informed accordingly (see Table 4.4).

Table 4.4. Implications of precipitation and temperature changes up to 2040

Region	Precipitation trends	Temperature trends	Implications
Central KP	Average Increase: 9% Winter: Decline by 17% Spring: Increase by 22% Summer: Increase by 24% Autumn: Decline by 33%	Annual average increase by 1.8°C Winter nights will be warmer by 0.9°C Winter days warmer by 1.4°C Spring nights warmer by 0.8°C Spring days warmer by 1.3°C Summer nights warmer by 2.1°C Summer days warmer by 1.3°C Autumn nights warmer by 1.8°C Autumn days warmer by 2.0°C	Torrential rains towards the end of spring Likelihood of flash floods in spring and summer River overflows in low lying areas during early summer due to snow melting in higher watersheds Frequent frost will be observed during dry and cold winters
South KP	Average Increase: 1% Winter: Decline by 19% Spring: Increase by 14% Summer: Increase by 17% Autumn: Decline by 32%	Annual average increase by 1.6°C Winter nights warmer by 0.7°C Winter days warmer by 1.4°C Spring nights warmer by 1.3°C Spring days warmer by 2.2°C Summer nights warmer by 1.1°C Summer days warmer by 1.6°C Autumn nights warmer by 1.8°C Autumn days warmer by 2.0°C	Dry spell in Autumn/ winter Torrential rainfall towards the end in spring Some of the Southern districts are at high risk of floods.

North KP	Average Increase: 4% Winter: Decline by 8% Spring: Increase by 14% Summer: Increase by 7% Autumn: Decline by 17%	Annual average increase by 1.9°C Winter nights unchanged (0.1°C) Winter days warmer by 1.9°C Spring nights warmer by 1.4°C Spring days warmer by 2.4°C Summer nights warmer by 1.6°C Summer days warmer by 2.3°C Autumn nights warmer by 1.9°C Autumn days warmer by 2.0°C	Flash floods in spring and summer due to intense rains. Coupled with increased temperature, GLOF and avalanches are highly likely in high mountain regions as well as river flooding in spring / summer.

These trends are important for mapping hydro-meteorological risks in KP province. Based on consultation with some of the key experts in disaster risk management, Table 4.5 gives an indicative analysis of potential multi-hazards in the individual districts of the province drawing on the trend over the last decade. The ranking in these tables is based on the temperature and precipitation scenario and existing fragility features within the districts (such as topography, terrain, and urban density).

Table 4.5. Multi-hazards vulnerability classification of KP districts (2020)

S.No.	Districts	Flood	Flash Flood	Urban Flood	Drought	Landslide	GLOF	Multi-hazards Vulnerability Index (MHVI)
1	Chitral							14
2	Upper Dir							12
3	Lower Dir							8
4	Swat							12
5	Malakand							8
6	Buner							7
7	Battagram							10
8	Torghar							8
9	Shangla							9
10	Kohistan							11
11	Mansehra							10
12	Abbottabad							9
13	Haripur							7
14	Mardan							10
15	Charsadda							8
16	Swabi							5

17	Nowshera							7
18	Peshawar							10
19	Bajaur							7
20	Mohmand							7
21	Khyber							7
22	Orakzai							6
23	Kurram							4
24	Kohat							4
25	Hangu							4
26	Karak							5
27	Bannu							6
28	Lakki							5
29	Tank							8
30	D.I. Khan							9
31	N. Waziristan							8
32	S. Waziristan							9

Hazards Classification			
Nil = 0	Low=1	Medium=2	High=3

In summary, the post 2030 period is critical for KP province in terms of water availability from precipitation. Therefore, the best option over the next few years is to focus on optimal seasonal water management by improving rainwater harvesting infrastructure, conserving watersheds and defining appropriate agricultural zoning. For agriculture, it is important that the shifts in climatic trends are interpreted to define the impact on farming and plausible adaptation measures - such as changes in cropping patterns, technology, and crop varieties. Without this, economic returns to the province will continue to diminish, farmers will lose their livelihoods and food security will be threatened. So, there is dire need to transform the climate related threats into opportunities through adaptation. A massive training programme for agriculture planners, extension workers as well as farmers is necessary to provide and implement relevant advice.

Chapter 5

Forests for regulating water flow

Moist temperate forests in District Mansehra

Chapter 5
Forests for regulating water flow

Arjumand Nizami
Syed Nadeem Bukhari
Shafqat Munir

Forests are subject to multiple environmental demands such as water regulation (volume and quality), ecological functions and carbon sinks, in addition to meeting needs for timber, fodder, and energy (Figure 5.1). The Green Growth Strategy (2018-2023) of KP province recognises this variety of demands and aims to align the priorities of the forestry sector with fulfilling them. Pakistan is part of the Indus basin. Major watersheds in the North of KP province contribute to flows of the Tarbela and Mangla dams whereas water from the Western mountains drains directly into the Indus River via the Kurram River, other small streams and the *Rudh Kohi* system.

Figure 5.1 Multiple demands on forests

5.1 Assessment of KP's Forests

The first comprehensive assessment of the total area of natural forests in Pakistan was accomplished in 1990 under the Forestry Sector Master Plan study (FSMP). However, the first reliable and accurate data on the area of forests in KP province were produced under the Provincial Forest Resource Inventory – PFRI (Häusler et al., 2000).[4] Results of the PFRI study showed that 6,772 km^2 area was covered by forests in the civil divisions[5] of Malakand and Hazara in 1996. Most natural forests occur in these two civil divisions.

[4] The PFRI used LANDSAT TM satellite data supported by an extensive physical ground survey of 768 sample plots selected through a standardized random procedure on statistical parameters.
[5] The term "Division" in this report always refers to Civil Division of the general administration.

Malakand and Hazara[6] constitute 45% (46,138 km^2) of KP province or 5.2% of Pakistan's land area. The forest area in this region constitutes 6.7% of the total KP province land area or 0.8% of the country's land area.

The PFRI used the physical definition of forests according to FAO standards[7] for that purpose. In KP, the forest areas have also been classified by legal definitions. These are forest areas that are under the custody of the Forest Department (FD). These forests are regularly covered by forest working plans for management purposes. Their total area is 841,517 ha. Of the total area, 7.6% (63,915 ha) are state-owned Reserved forests, 29.7% (250,106 ha) are Guzara forests owned either by community or private individuals and 62.7% (527,496 ha) are Protected forests[8]. Much of these forest areas are denuded of trees despite being legally classified as "forests". In 1996 all classified forests in KP province had at least some tree stands, albeit of different densities, on 438,607 ha or 52% of the total area legally classified as forests. In the case of the tribal districts (former FATA), the legal category of forests has not been determined and, therefore, all the forests are privately or communally owned under the tribes' own customary practices. No forest policies and laws have been extended to the tribal districts as yet. The total forest area in the newly merged districts is reported to be 529,282 ha (19% of total land area).

5.2 The trajectory of forest degradation

With an ever-growing population and increasing demands for wood and wood-products on a very small forest resource base, all forests in KP province have been under continuous stress. During the colonial period, such imbalances were managed through rather rigid forest laws and also partly compensated by the introduction of scientific forest management practices. With the creation of Pakistan, colonial forest laws were continued with only marginal adjustments. Under these laws, the government of Pakistan issued various forest policies substantiating forest management objectives and longer-term perspectives in forestry. So far, five policies have been formulated between 1955 and 1991. The implementation of these policies has however remained weak, and forest management in practice has continued under the colonial laws.

In KP province, 92% of the legally defined forests are either privately owned or subject to local community rights and concessions (Fischer et al., 2010). The owners of the Guzara forests and concessionaries of the Protected forests as well as non-right

6 There are a few natural forests also in other parts of Pakistan mainly in Punjab, Baluchistan and there are some forest areas in the Federally Administered Tribal Areas (FATA) along the border to Afghanistan. These forests are covering only small patches and are scattered over a wide area.

7 In the PFRI forests were identified as an area of more than 10 ha that has a tree stand of more than 10% canopy cover (FAO 1975; 2006).

8 Protected forests were formerly under the jurisdiction of the princely states; with the merger of these states into the territory of Pakistan these forests came under the custody of the forest department.

holders depend heavily on forests not only for subsistence (e.g. firewood, construction timber, livestock grazing) but also for their livelihoods through felling or cutting trees for additional income. There are also commercial interests that supply the timber market and serve to satisfy government revenues from forestry. Alongside there exists a large scale illegal commercial exploitation of forests by the so-called "timber mafia[9]". However, awareness on the environmental functions of forests for wider societal interests is also rising in the country. To promote the sustainable management of forests and biodiversity conservation, Pakistan has signed multilateral environmental agreements.

With the forests visibly deteriorating, certain quarters of the federal and provincial level governments have started blaming the Forest Department for mismanagement. Objections were raised from the Guzara forest owners on the harvesting system governed through Forest Department contractors. The harvesting system was hence taken away from the Forest Department and reorganised under a new parastatal Forest Development Corporation (FDC) in 1976. Later, the management of the Guzara forests was also transferred to the Guzara owners who organised themselves into forest co-operative societies (FCS). However, these attempts to improve forest management also failed because the co-operative societies of the Guzara forest owners were hijacked by larger owners and other vested interests to over-exploit the forests.

A devastating flood occurred in KP province in September 1992, causing tremendous physical damage and loss of life. The severity of the flood was attributed to the degradation of the forests in the catchment areas of the main rivers. The blame was placed on the forest co-operative societies for their alleged long-standing malpractices and mismanagement of the forests. Given the poor situation of the forests, and to concede to public pressure, the federal government imposed a general ban on commercial timber harvesting throughout Pakistan in September 1993. The ban was accompanied by an action plan addressing issues to be rectified in forestry with the ultimate objective to contain or even reverse the process of forest degradation. Having the largest natural forest area, KP province was the focus of the ban. With several renewals and a one-year relaxation in 2001, this ban remains in force to this day.

To explain the reasons for the declining forests, the PFRI study identified that the recorded commercial harvest accounted for only about 2.2% of the total wood consumption, whereas local consumption for firewood accounted for 80.0%, and other unrecorded harvesting accounted for 17.8% (Fischer et al., 2010). Thus, according to the PFRI, the forest deterioration was mainly due to firewood consumption by local people. The PFRI study concluded that with an ever-growing population, the forest will continue to deteriorate as the forest cannot be protected against the subsistence needs of the local people. Thus, the ban on commercial timber harvesting was addressing an issue that was only marginally contributing to the continuous degradation of the forests. The positive effect

[9] The term "timber mafia" is a colloquial term used throughout KP province to describe a group of people engaged in illegal timber harvesting for commercial purposes.

of the ban, however, was an acceleration in the implementation of an action plan leading to a comprehensive revision of provincial forest policy and the colonial forests laws, and a restructuring of the forest administration in KP. The new policy also integrated almost all major demands of the federal government and international donors regarding participatory forest management under multiple forest functions from a conservation and environmental protection perspective.

The reorganization of the Forest Department had a limited impact. Among other reasons, this was because of inadequate acknowledgement of the complex realities of tenure and lack of trust in people's abilities to manage forests (Geiser et al., 2004; Shabaz and Geiser, 2009) as well as the recognition that human pressure to access forests for firewood was a significant factor in changing forest cover (Häusler et al., 2000; Fischer, 2010). The volumes of illegal harvesting and marketing (already prevalent prior to the ban) continued at a rate over ten times greater than the timber harvest recorded by the Forest Department. As a result, from 1996 to 2008, the forest cover[10] in KP province further decreased from 677,230 ha to 570,221 ha (Fischer et al., 2010). Thus, an area of 107,009 ha (15.8%) was reduced to a density of 10% or less - which according to FAO definitions is not forest. Nevertheless, it remains a legal forest area under the management of the Forest Department. Stand density has also reduced in the remaining forests. Altogether the forests have been reduced by 46,656 million m^3 of their growing stock or almost 25% when compared to 1996. Forests located in areas below 2,000 MASL saw a downward shift in density, losing almost 33% of their stock (ibid). The decrease of 15.8% forest land was due to land use change from forest to other uses and the complete denudation of some areas. Of the total wood consumption of 52.2 million m^3 recorded in this period, 2% was recorded as commercial harvesting and 84% was attributed to firewood consumption. The remaining was unrecorded harvesting attributed to (1) local people supplementing their meagre incomes for subsistence purposes and (2) organised gangs (the "timber mafia").

Despite the known facts about the rapidly disappearing forests and the underlying causes, no affirmative changes in forest administrative structures or policy to engage local opinion and ground realities, was forthcoming. The management approach of the Forest Department continued to assume that the forests of KP province will flourish again with an appropriate technical forest management system. A well-conceived strategy to address the real problem of the energy requirement of the local people could not be devised and the forests continued to disappear.

The preceding pages have reflected the dire challenges faced by the forestry sector of KP province as reported until 2008. This may be summarised as follows:

[10] Land covering more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use (FAO 2006).

1. Multiple demands and a large supply-demand gap. With a total stock of 142 million m^3 and a recorded annual harvest of 6.5 million m^3 in 2008, the actual stock will continue to decline – negatively affecting the ecosystem services of the forests.
2. Between 1996 and 2008, 107,009 ha (15.8%) of the forest cover has been lost and some has been changed to other land uses.
3. In 1996 the PFRI already extended a warning that if the pattern of degradation continued, in 25-30 years there will be no usable natural forest left.
4. Over 80% of the out-take is attributed to energy requirements, exceeding the regenerative capacity of the forests. A switch to alternate energy sources has been extremely slow – only 5% between 1996 and 2008. Even if this may have been doubled by 2018 to 10%, it is very low in comparison to population growth (Hazara and Malakand divisions). This has been over 100% since 1996, with a population of 16 million in 1996 increasing to 35 million in 2017[11].
5. Forest density classes have degraded to lower density classes in hilly areas especially at altitudes over 2,000 m asl. This has implications for the regulation and overall availability of water resources.
6. Strict command and control alone have not brought much success to reverse the degradation process; therefore, frequent policy changes have been made from time to time. This realisation surfaced from within the Department and led to forestry sector reforms and new rules for community participation.
7. KP is the only province in Pakistan to have repealed pre-independence laws and introduced new forest laws and rules to ensure local participation. The impact of this development is, however, yet to be seen.

5.3 The Green Growth Programme

An emergency regime was required to address rising energy demands and reduce the demand and supply gap. It was particularly necessary to restock forests in low and medium density classes (below 50% crown density) in mountainous areas over 2,000 m asl.

Recognizing this challenge, the government of KP province committed to restore 384,000 ha of forest by June 2020 under a Green Growth Programme (Forest Department, 2018). This was also spurred by commitments to new global mechanisms including the Sustainable Development Goals (SDGs 13 and 15) and the Aichi Biodiversity targets set out in the Conference of Parties-10. The Forest Department was assigned the task of rehabilitating and developing forest resources to address the acute situation at hand.

The overall mission of the Green Growth Programme is to improve the forest cover, rehabilitate the degraded forests and restore the disturbed forest ecosystem, thereby increasing supply and bridging the gap between supply and demand. Strong reference in the action plan of the Green Growth Programme was made to the PFRI findings (78% of forest ar-

[11] http://www.pbs.gov.pk/

eas being under-stocked with a crown cover below 50%, of which 74% need immediate regeneration measures). In devising the strategy, the rising energy demand and scarcity of resources were recognized as leading problems. The main pillar of the initiative was the launching of the Billion Trees Tsunami Afforestation (BTTA) Project (Figure 5.2).

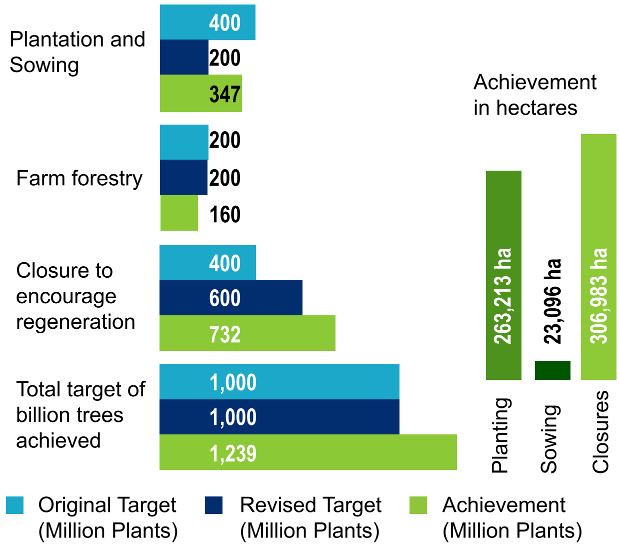


Figure 5.2. Green Growth Programme 2015-2020 – Billion Trees Tsunami

The Forest Department has reported (Forest Department, 2018) that as a result of the Billion Trees Tsunami Afforestation (BTTA) project, 676,136 ha of tree cover (6.3% of the total area) has been added to the existing forest area. This includes 23% of the 74% area indicated by the PFRI as having no regeneration. Under the BTTA project this area was restored through enclosures, reforestation of 7,148 ha retrieved from "adverse possession" and 1,430 ha that needed land stabilization. The target of one billion trees was completed by planting 347 million trees (203,239 ha), direct sowing (23,096 ha), 160 million through farm forestry, and 732 million through the conservation of natural regeneration in enclosures in denuded forests. With respect to increased forest cover, enclosures contributed 1.3%, fresh plantations and sowing contributed 3.1% and farm forestry added 1.9% forest.

The high-altitude forests are the key to conserve the water towers of the country and hence hold great significance for the province. Taking the entire history of events since 1970s and the measures adopted by the Forest Department and partners, massive progress has been made in recent years to reverse the steep decline in forest cover. To some extent, the intensity of degradation has also been reduced by strengthening the system of enclosures. However, the very basic issue of forest governance and a continuous leakage from natural forests, especially from those at high-altitude, requires continuous attention to prevent what was reported in 2008.

The Forest Department had two options to meet the gigantic target set in the BTTA project: either to recruit project staff at the cost of time and resources, or to involve local communities following the KP Forest Act, 2002 and the Community Participation Rules, 2004. The latter course of action was preferred over new recruitment and paved the way to the practical application and implementation of newly enacted laws and rules, setting an example for other regions.

The idea of sustainable forest management has always been supported by various documents prepared during the forestry sector reform process. The BTTA project took several elements from the reformed framework (including the Community Participation Rules, 2004) and re-instigated the idea of participatory sustainable forest conservation and management. In the longer run, it is important to fully institutionalise the important role of forests in watershed protection and water regulation, engaging local people.

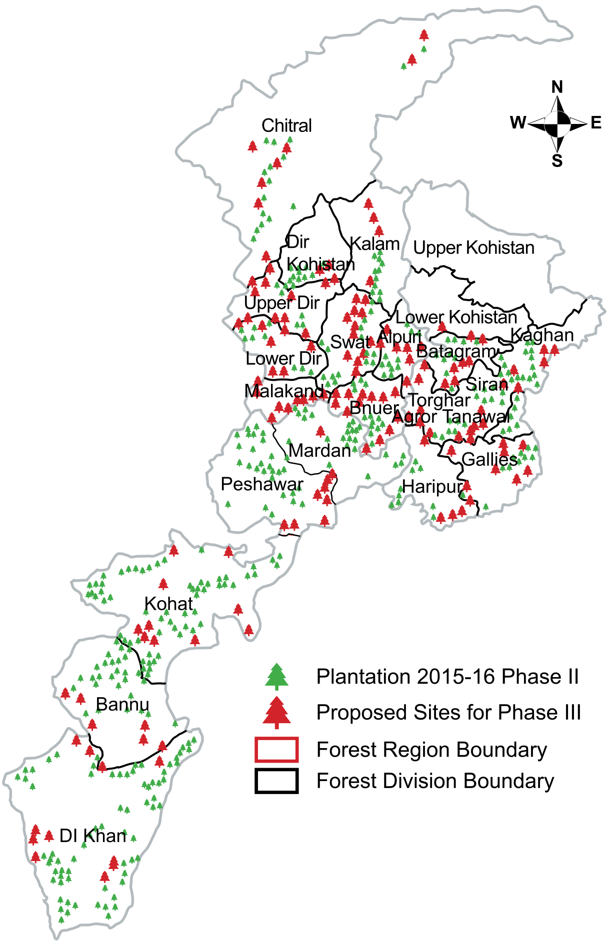


Figure 5.3. Map of Phase II plantation and proposed sites for Phase III of the BTTA project

Chapter 6

Hydrology

River Indus in District Nowshera

Chapter 6
Hydrology

Naveed Iqbal
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According to the Water Apportionment Accord, 1991, a total of 8.78 MAF of water, amounting to 7.7% of the total available, has been allocated to the province of KP from the Indus Basin River System (GoP, 1991). Against this, the province could utilize only 5.97 MAF with an annual unused surplus resource of 2.81 MAF (Table 6.1). The withdrawal of 5.97 MAF is carried through several canals which will be explained in later sections.

Table 6.1. Water Apportionment Accord 1991

Present Water Utilization in Khyber Pakhtunkhwa (KP)	
Description	**MAF**
Total MAF Indus River System	114.35
Total water allocated to KP (7.7%)	8.78
Present withdrawal KP	5.97
Non-withdrawal due to lack of infrastructure	2.81 (about 30% less annually)
Source: Irrigation Department, Government of KP 2019	

6.1 Major surface water bodies of the province

KP province's water comes from 6,100 km of rivers and streams, 6,400 ha of lakes and 54,600 ha of dams and reservoirs which also serve as fish farms for around 3,200 tons of harvest per year (Khan, Khalil and Mohammad, 2019). The annual surface water flows are carried by the 11 major rivers and streams traversing the province. The total surface flow is about 29.51 MAF (ibid) which include 3.99 MAF flows of the erstwhile FATA rivers and Zams (hill torrents) (PCRWR and IUCN, 2018).

The main river system in the province is the Indus, which originates in the Tibetan Plateau in Western China. Passing through Pakistan to flow into the Arabian Sea, it is a lifeline for the economy of Pakistan. The river has a total drainage area exceeding 1,165,000 km^2 (450,000 square miles), making it Pakistan's largest river. In terms of annual flow of 229 cubic km (Young, 2019), it is the 21st largest river in the world. The Zanskar is its left bank tributary in the Ladakh valley, whilst its principal right bank tributaries are the Shyok in Gilgit, and the Kabul, Swat, Gomal and Kurram rivers that join it from the Western side of KP province. The Indus is a transboundary river with a total area of 1.12 million km^2 distributed between Pakistan (47%), India (39%), China (8%) and Afghanistan (6%) (FAO, 2011). Some 65% of Pakistan's territory is fed by this river, comprising the whole of Punjab, KP, GB and AJK provinces, as well as most of Sindh and the Eastern part of Baluchistan (ibid).

The waters of the Indus support complex ecosystems and economic growth, fulfilling food security and energy demands. The Indus also serves to promote political stability in the region. The river's upper catchments and its tributaries in the Himalaya and Hindukush hold large quantities of ice in the form of glaciers and permanent snow on high peaks.

The Indus sustains one of the largest integrated irrigation systems in its command. Excepting Hazara division, the entirety of KP province is located along the right bank of the Indus. Within the province, the Indus feeds the Pehure main canal on its left bank from the pond of Ghazi Barotha hydel project and the Pehure high level canal through the

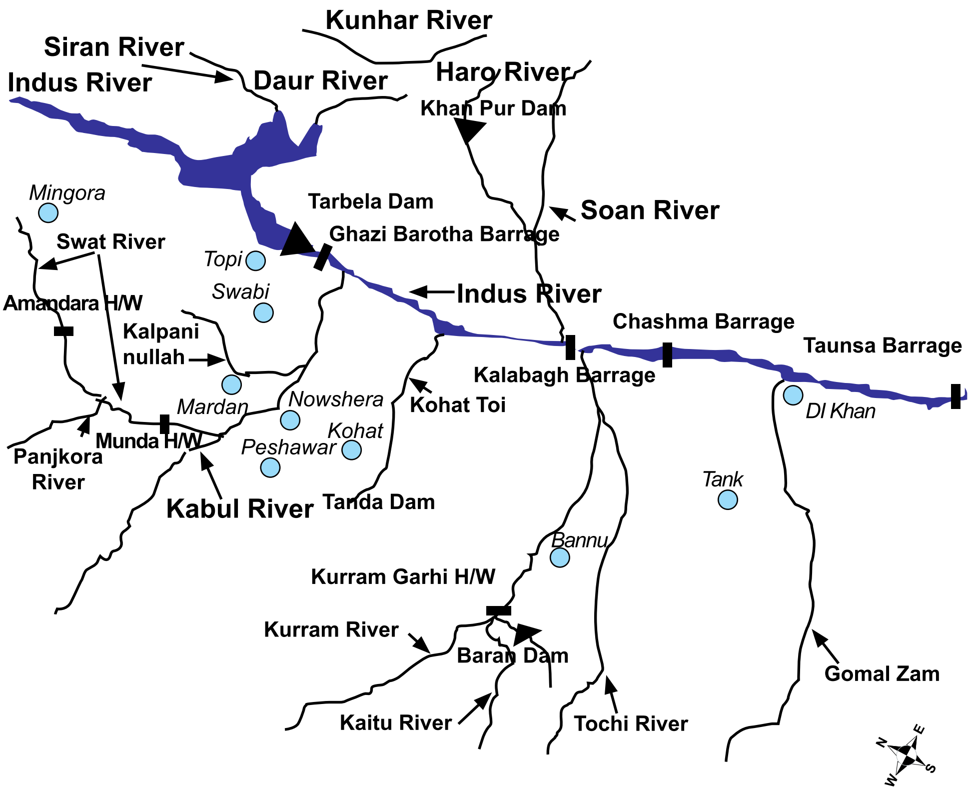


Figure 6.1. Map of major rivers in KP province

Mufti tunnel from the reservoir of the Tarbela dam. The command area of both these canals is situated in Swabi and Nowshera districts. Another major irrigation system taking water from the Indus is the Chashma right bank canal which feeds a wide command area in the district of Dera Ismail Khan; the balance is conveyed to Punjab province. Figure 6.1 and Table 6.2 provide a detailed overview of the tributaries of the Indus within KP province and their annual flow. Of these, four major tributaries (Kabul, Swat, Panjkora and the Zams) are described in the following section.

Table 6.2. Basin wise catchment area (Sq. km) and average annual flow (MAF)

S/No.	Name of sub basin	Catchment area (km^2)	Average annual flow (MAF)
1	Swat River	14,000	3.54
2	Panjkora River (Dir)	13,000	2.60
3	Kabul River	66,000	19.00
4	South KP hill torrents[12]:		Individual data not known – a collective flow of 2.47 MAF has been documented[13]
	• Gomal Zam	8,651	
	• Tank Zam	2,357	
	• Sheikh Haider Zam	453	
	• Chodwan Zam	921	
	• Draban Zam	1,096	
5	Siran River (Hazara)	1,255	0.47
6	Kurram River	4,552	Individual data not known – a collective flow of 1.52 MAF has been documented[14]
7	Tochi River	4,938	
	Total		**29.6**
Source: PCRWR and IUCN, 2018 and Khan, Khalil and Mohammad, 2019			

Swat River

This river originates in the Hindukush Mountains of Swat Kohistan. Its catchment comprises snow-bound high mountains in the Northern part of the province up to an elevation of some 4,877 m asl. The main river flows for some 162 km until its confluence with the Panjkora River; a further 231 km takes it to its outfall into the Kabul River, opposite Jala Bela and Agra payeen. The main government-operated canal systems from the Swat river are the Fatehpur, Nipki Khail, Badwan, Upper Swat, Lower Swat and Doaba. In addition, there is a network of hundreds of civil channels removing water from the river. The command area of the river is situated in the districts of Swat, Dir, Malakand, Mardan, Nowshera, Mohmand and Charsadda. The total command area is around 14,000 km^2 up to the Kabul River. According to available data over the last 30 years, the average annual discharge at Amandara headwork ranges from 1,800 cusecs to 8,000 cusecs, resulting in an average dependable volume of about 3.54 MAF.

12 Locally called zams, which are managed under the so called *Rudh Kohi* or hill torrent system of water management.

13 According to a National Food Security Study the annual potential of hill torrents is 19 MAF at national level, of which KP's potential is 13% (2.47 MAF).

14 River discharge data mentioned in this table are simulated discharges of major rivers from 2003-2014 using Climate Forecast System Analysis (CFSR) generated through SWAT model. PCRWR & IUCN, 2018.

Panjkora River

This river originates from Dir Kohistan at about 4,570 to 4,880 m asl from the permanent snow bound peaks of the Hindukush. After flowing some 90 km through Upper and Lower Dir districts, it discharges into the Swat River at Bosak in Malakand district, 4.5 km downstream of the Quolangai bridge. The Panjkora derives its name from the five main tributaries feeding it: the Dir, Kohistan, Barawal, Usherai and Maidan nullahs - *panj* meaning five. The catchment area is about 1,300 km^2, spread over the high mountainous range that ends near Lowari top, close to the boundary of Chitral district. Three government canals and dozens of civil channels in Upper and Lower Dir districts are fed by the Panjkora. After discharging into the Swat, the Panjkora provides water to the Lower Swat canal system which has its command area in Charsadda, Mardan and Nowshera districts. It also provides water to hundreds of civil channels in these districts. As per available data over the last 30 years, the dependable discharge ranges between 1,200 and 6,000 cusecs, an annual volume of about 2.6 MAF (Government of KP, 2019).

Kabul/Chitral River

The Chitral River has its major catchment area of about 2,600 km^2 in Chitral district before entering Afghanistan, flowing into the Kabul River near Jalalabad, and then re-emerging in Pakistan. It is about 224 km long in Chitral and 256 km in Afghanistan. It re-enters Pakistan as the Kabul River about 12 km North of the Torkham border at an elevation of some 380 m asl and flows about 157 km from Torkham to the point at which it discharges into Indus near Attock. The Kabul River in Afghanistan is a combination of two major branches, the Chitral and Kabul. Being about 637 km long in total, it has a catchment area of about 66,000 km^2 in Afghanistan and Pakistan combined. This river not only feeds several small-scale irrigation channels in Chitral district; it also plays a very important role following its re-emergence in Pakistan in turning the Warsak powerhouse. This adds more than 200 MW electricity to the national grid and provides water to the centuries' old irrigation system of Peshawar valley, including a network of civil channels. The Kabul River canal system and the Warsak canal system have their command areas in the districts of Peshawar, Khyber and Nowshera. The Kabul River has an annual water input of about 19 MAF at Attock (Shah and Hay, 2015). Historical data from 1937 to 2008 indicate a considerable decrease of inflow in the Kabul River from 28 MAF to 19 MAF. This is likely due to climatic variability, persistent drought, and increased use of water in Afghanistan (ibid).

Zams/Streams Emerging from Tribal Districts

Several streams and rivers collect water from the mountains of the Hindukush, covering seven tribal districts, which ultimately flow into the Indus River system. In Bajaur, the Khazana River feeds a few local civil channels before entering the Panjkora River downstream of Timergara town. In Khyber, the Bara River emerges from the mountains of Khyber and Orakzai, provides irrigation water to a few government and private channels, and then flows into the Kabul River. The detailed design of the Bara dam is planned be physically implemented and will irrigate the fertile land located in the South of Peshawar valley.

The Kurram River has its catchment area in the snow-covered mountains of the same name. It traverses Eastwards and provides irrigation waters to the historical civil canal systems of Bannu and Marwat in Lakki Marwat district. The Tochi River emerges from the hills of North Waziristan, joining the Indus after feeding the local civil channels. There is a plan to divert water from Tochi River through a weir to feed the Baran Dam; this will allow it to regain its storage capacity and feed the existing command area of Marwat canal. The Gomal River gathers its waters from the hilly catchment of South Waziristan. The recent construction of the Gomal Zam dam has not only added 16 MW of electricity to the national grid but has also ensured regular irrigation supplies to the vast fertile land in Tank and DI Khan districts. Besides Gomal, other Zams namely the Tank, Draban, Sheikh Haider and Chodwan also carry a sizeable amount of hill torrent waters emerging in Baluchistan and the tribal districts. Finally, the Jandola and Kaitu are small streams in the southern tribal districts which also release their surplus flood water into the Indus River.

In the erstwhile FATA, the surface water potential is about 3.99 MAF while the groundwater potential is estimated as 0.12 MAF[15]. The current annual utilisation in the tribal districts is only 0.10 MAF with a current surplus of 4.01 MAF[16]. The major share of water is utilised in meeting drinking water requirements, both domestic (74%) and for livestock (25%). However, a very meagre share is used for cropping activities due to the undulating topography, lack of storage infrastructure and other challenges. Therefore, most of the available water resource escapes the system as runoff. This potential needs to be harvested to improve the livelihoods and socio-economic condition of the people living in this region of high poverty.

6.2 Canal system

Various canals have been constructed for irrigation purposes in the province. These canals are described in brief below (Government of KP, 2019)[17]; a summary is provided in Table 6.3.

Pehure High Level Canal

The Pehure high level canal system was completed in the year 2001 to feed a new area of about 32,780 ha and to augment supplies to the existing command area of about 35,208 ha in the tail areas of the Upper Swat canal system, which suffered from chronic water shortages. The canal is taken off from the Mufti tunnel, constructed across the right abutment of the Tarbela dam. This system has increased the intensity of irrigation to the desired amount.

Chashma Right Bank Canal System / Paharpur Canal

The Paharpur canal was first constructed as an inundation canal in the year 1906-1908. The system was remodelled for enhanced discharge in the year 1932 by

[15] Physical observation data in tribal districts. PCRWR and IUCN, 2018
[16] Assessment of water resources in FATA by PCRWR & IUCN, 2018
[17] Data obtained from the Irrigation department KP, 2019

the British government but was not successful until the construction of the Chashma barrage in the year 1977. The Chashma right bank canal system feeds a total of about 230,671 ha with 187,369 ha lying in the district of Dera Ismail Khan of KP; the rest is in Dera Ghazi Khan of Punjab province. This system was constructed by the Water and Power Development Authority, Pakistan (WAPDA) in 1992.

Pehure main canal

The Pehure main canal with its cultivatable command area of about 43,490 ha was constructed in 1957. The natural off-take head of the canal was submerged following the construction of the Tarbela dam reservoir; WAPDA then installed a pump house to feed this old canal system from downstream of the dam body. Following the construction of Ghazi Barotha power project, the diversion pond again made gravity flow possible, without any need for pumping.

Kabul River Canal

The history of the irrigation system in KP province begins in the Mughal era, when the Jo-e-Sheikh canal was first constructed by the Mughal king Aurangzeb Alamgir in the late 16^{th} century. This was followed by the successful completion of several other civil canals in the area. The first regular canal was started in the British era when the Kabul River canal was constructed in the year 1883. This also fed the Jo-e-Sheikh canal which was previously run as an inundation channel. The system is one of the oldest in the region and feeds about 29,137 ha of fertile land in the Peshawar valley. The system currently runs successfully and following the construction of a permanent diversion weir across the Kabul River, its tail shortages have been controlled. The three branches of this system namely the Jo-e-Sheikh canal, Kabul River canal and Hazarkhani branch traverse a densely populated area of Peshawar metropolitan. As a result, Peshawar has become one of the dirtiest cities in the province as all the effluent and solid waste of the city is criminally dumped into these water bodies. Coordinated efforts and planning by the Irrigation Department and the Water and Sanitation Services Peshawar Company (WSSP) are urgently needed to ensure an alternative arrangement for the disposal of this matter. Such an improvement to the system would not only control the environmental hazard but could add significantly to the beauty of the city.

Lower Swat Canal System

The Lower Swat canal system was completed during the British regime in 1885. The system feeds about 54,430 ha in the districts of Charsadda, Mardan and Nowshera. It was remodelled during 1991 when its discharge capacity was enhanced by 1,940 cusecs. Historically, it has been a successful system but due to the winter shortage of water flowing into the Swat River, the system is now run on weekly rotational arrangement. This affects the overall cropping intensity in the command area. The system was hit by various floods during its long life, but the devastating floods of 2010 destroyed its headworks and the downstream canal system. These damages were quickly restored with an improved design. Nevertheless, the province needs the early construction of the upstream Munda/Mohmand dam. This will not only bring an additional area of about 6,475 ha under command but will also ensure full time water availability to the Lower Swat canal system for the Rabi cropping season (in the winter, with harvesting in the spring), without any weekly rotational arrangement.

Upper Swat Canal System

The Upper Swat canal system was also completed during the British era in 1914, and runs with all historical success, feeding a cultivatable command area of 113,717 ha in the districts of Malakand, Mardan, Charsadda, Swabi and Nowshera. The system was remodelled in 1999 to enhance its discharge by 3,600 cusecs. The headworks and main canal were severely damaged by the floods of 2010 but were quickly restored. The system takes water from the Swat River at Amandara and passes across the Malakand hills through the Benton tunnel constructed during the British era and the Benazir tunnel constructed during the remodelling of the system in the late 1990s. There are three power houses on this system which add about 124 MW of electricity to the national grid.

Warsak Canal System

The Warsak canal system was constructed during the mid-1960s with the help of the Canadian government for a total command area of about 46,844 ha. The system comprises the Warsak gravity canal, Warsak lift canal and Warsak left bank canals. The command area of these canals is spread across the districts of Peshawar, Nowshera, Khyber and Mohmand.

Kurram Garhi Headwork

The Kurram Garhi project in Bannu district was first initiated as an inundation canal in the year 1907 under a temporary arrangement by then Executive Engineer Mr. J.C. Dewis. The system was later converted into a regulated canal system by constructing the Kurram Garhi headwork in the year 1954. The system feeds about 42,492 ha of a civil canal system without any water charges due to their pre-existing water rights known as *Haqdari.*

Baran Dam

The Baran dam system was constructed in 1962 on the Baran *nullah* (stream). Later, a feeder channel from the Kurram River was constructed due to the poor hydrology of the Baran *nullah*. After successfully feeding a command area of about 68,797 ha for several decades, the system is now almost non-functional due to the siltation of the reservoir. The system is being reactivated by raising the dam body and constructing a new feeder canal from the Tochi River. This project has been put to tender and should be completed within about three years.

Gomal Zam

The dam portion of the Gomal Zam Project was completed in 2013 while the irrigation system was completed in 2015. The project is not only adding 17.4 MW of electricity to the National Grid but also irrigates a new area of about 531,393 ha along with regular irrigation to the existing 10,400 ha of the previous inundation canal system.

Bazai Irrigation Scheme

The Bazai irrigation scheme was intended to irrigate about 10,117 ha and was constructed on the silt ejector of the power channel of the Malakand III power project. The project was completed in 2016 and its command area is being gradually improved. There is a need for a separate command area development project to ensure full benefits from the project.

Civil Channels

There are more than 3,000 civil channels (with an average command area of 101 ha per channel) within the province, including the tribal districts. These civil channels are non-revenue channels, maintained by the irrigators themselves. They utilise a sizable quantity of irrigation water (3.00 MAF allocated under the Water Apportionment Accord, 1991).

Table 6.3. Summary of major canal systems in KP province

S/No.	Name	Length (km)	Discharge (cusec)	Command area (ha)
1	CRBC (KP portion)	724.00	3,000	141,640
2	Pehure main canal system	121.60	250	18,166
3	Pehure high level canal	25.60	1,000	4,262
4	Upper Swat canal system	841.60	3,600	113,717
5	Lower Swat canal system	308.80	1,940	54,430
6	Warsak canal system	198.40	595	43,469
7	Kabul River canal system	121.60	800	29,137
8	Tanda dam canal system	89.60	363	12,788
9	Marwat canal system	267.20	800	68,999
10	Paharpur canal system	264.00	870	45,749
11	Bannu canal system	256.00	600	43,504
12	Balambat irrigation scheme	75.80	125	4,598
13	Siran canal system	149.00	75	4,553
14	Bazai irrigation scheme	39.31	200	10,117
15	Civil canals			303,514
	Total	**3,483**	**14,218**	**898,643**
Source: Irrigation Department, Government of KP, 2019.				

6.3 Precipitation

As noted in chapter 4, KP province has a higher average precipitation compared to the rest of the country. The calculated annual rainwater harvesting potential in the province is about 4 MAF. So far, the province has been able to harvest only about 281 acre feet local surface runoff through the construction of 43 small dams (Government of KP, 2021). Rainwater harvesting and storage in the province should further improve substantially with the construction of the Mohmand, Gomal Zam and Kurram Tangi dam projects as well as 33 more small dams planned within the coming few years. As a result of the mountainous topography of KP province, it has a tremendous potential for small and medium dams. The history of small dams construction in the province begins in the 1960s with the completion of the medium scale Baran dam in Bannu in 1960. Three other small dams, namely the Tanda and Kandar dams in Kohat and the Khal dam in Haripur district were also completed in the same era. Despite such high potential, the provincial government paused unduly for 20 years before recommencing dam construction in 1984. The Irrigation Department established a dedicated directorate for small dams in the early 1980s. The Department has constructed 43 small dams, a few of which are in final stages of completion. These dams are also source of drinking water in many areas as well as helping to control floods and providing a recreational facility. In addition, the groundwater aquifer downstream is recharged. A summary of small dams in KP province is provided in table 6.4.

Table 6.4. Details of small dams in KP province

S/No.	Name of dam	Districts	Command Area (Ha)	Storage (m^3)
1	Baran dam	Bannu	68,999	98,000
2	Tanda dam	Kohat	12,788	99,000
3	Kandar dam	Kohat	567	2,650
4	Darwazai dam	Kohat	263	1,500
5	Khal dam	Haripur	809	830
6	Chatri dam	Haripur	243	540
7	Khanpur dam	Haripur	1,416	9,300
8	Gandially dam	Kohat	5,578	13,784
9	Chanda Fateh Khan dam	Kohat	645	1,593
10	Aza Khel dam	Peshawar	1,352	3,340
11	Auxiliary Kandar dam	Kohat	539	1,333
12	Naryab dam	Hangu	1,263	3,120
13	Sharki dam	Karak	4,045	9,996
14	Changhoz dam	Karak	4,674	11,550
15	Barghanatu dam	Bannu	864	2,135
16	Loughar dam	Karak	1,293	3,195
17	Karak dam	Karak	627	1,549
18	Khairbara dam	Haripur	202	489
19	Jabba Khattak dam	Nowshera	83	465
20	Palai dam	Charsadda	1,457	3,600
21	Dalmalak dam	Kohat	1,416	8,497

22	Ghole Banda dam	Karak	607	5,323
23	Mardan Khel dam	Karak	526	2,800
24	Kundal dam	Swabi	5,342	10,135
25	Zamir Gul dam	Kohat	1,200	6,691
26	Gul Dheri dam	Nowshera	648	1,000
27	Ghanghra dam	Haripur	809	1,329
28	Kiyala dam	Abbottabad	1,214	1,023
29	Gadwalian dam	Haripur	1,497	1,294
30	Jalozai dam	Nowshera	364	1,277
31	Shah Kaleem dam	Nowshera	222	647
32	Marobi Dam	Nowshera	1,214	5,083
33	Satti Kalli Dam	Bannu	1,052	4,334
34	Latamber Dam	Karak	324	1,820
35	Chapra Dam	Haripur	1,012	597
36	Jaroba Dam	Nowshera	376	1,001
37	Bada Dam	Swabi	1,214	4,331
38	Ichar Nullah Dam	Mansehra	1,416	6,338
39	Manchura Dam	Mansehra	2,023	3,661
40	Sanam Dam	Dir (Lower)	8,191	1,125
41	Khattak Banda Dam	Kohat	1,200	6,957
42	Makh Banda Dam	Karak	293	946
43	Pezu Dam	Pezu	865	2,037
	Total		**140,732**	**346,2154**[18]
Source: Directorate of Small Dams, Government of KP, 2021				

6.4 Groundwater potential

The exact groundwater potential of the province is not fully known. A few studies interspersed by long time intervals have been conducted in the Southern tribal districts and Peshawar valley, and there is some data on tube wells, but with these exceptions, there is very little information about groundwater in KP.

A historical and systematic groundwater study titled “Groundwater Investigation in NWFP” (Kruseman et al., 1988) widely known as the TNO study, was conducted for the alluvial Barani plains covering an area of 16,500 km^2. This study provided a baseline for future investigations and highlighted the need to update findings at regular intervals. This was not achieved until 2014 when the study was repeated in four districts by the directorate general of small dams. The original TNO study indicated that the province’s annual groundwater potential was 0.162 MAF. It further concluded that the topography

18 Acre Foot equals 1233.48 cubic meters

of KP province, poor watershed management and unplanned groundwater exploitation posed threats to its water security and affected its resource base. The follow-up study in 2014 found that groundwater reserves had deteriorated. It recorded 14,833 tube wells extracting 0.169 MAF water annually in the districts of Karak, Bannu, Lakki Marwat and Haripur. These included public and private tube wells for irrigation, tube wells installed by the Public Health and Engineering Department (PHED) for drinking water, pressure pumps, hand pumps, open wells, infiltration galleries and springs (in the case of Haripur, industrial tube wells were included).

According to data collected in 2019 from the On-farm Water Management Directorate of the Agriculture Department, the Public Health and Engineering Department and the Local Government Department, the total estimated number of tube wells (excluding those in newly merged districts) was 37,117 with a total estimated annual extraction of 3.97 MAF. These figures seem very conservative in comparison with the study conducted in 2014 which revealed that 40% of this total abstraction constitute in only four districts (Karak, Bannu, Lakki Marwat and Haripur).

A comparison of the data collected in 1988 and 2014 shows that extraction exceeds recharge. As per 1988 study, the total annual recharge was 0.159 MAF while extraction was 0.1172 MAF in Karak, Bannu, Lakki Marwat and Haripur. Therefore, the water balance was increasing by +0.0419 MAF. However, the 2014 study conducted in the same four districts revealed that the total annual recharge was 0.3687 MAF, with an extraction of 0.3841 MAF and a water balance of -0.0154 MAF, thus depleting groundwater reserves. Data from these two studies also reveals that groundwater quality has deteriorated and the water table has lowered. During the period from 1988 to 2014, the minimum groundwater depletion was noted as 4 m, which varies and, in some places, touches 36 m (Khalil et al., 2019).

An assessment of groundwater resources was also conducted in the tribal districts of Bajaur, Mohmand and Khyber (ADB and FDA, 2010). This study concluded that water resources in these districts are under stress. The aquifer seems to fluctuate considerably, driven by seasonal variations. In hot weather, the water level in open wells drops and can even dry up completely - while in the rainy season, the water level increases. The groundwater quality analysis carried out in the three districts found that water quality was satisfactory in terms of EC (electrical conductivity) and TDS (total dissolved solids) values. In terms of mineral content, it could be used both for drinking and irrigation purposes except at one location in Mohmand district, where the EC value was over 2,000 μ/cm[19]. The study found the total annual recharge to be 0.212 MAF and discharge 0.78 MAF, meaning an annual depletion of 0.568 MAF. This is far larger than the depletion in Southern districts outlined above. The water table was found to lie between 8 and 88 m. A recent study conducted in seven tribal districts (PCRWR and IUCN, 2018) indicated that a total groundwater potential of about 0.12 MAF is available annually. Out of this, the

19 Groundwater study in Bajaur, Mohmand & Khyber, 2017 (in progress)

districts of North Waziristan (29%), South Waziristan (24%), Khyber (18%) and Kurram (14%) together constitute a major groundwater potential of about 84%. The remaining 16% of groundwater reserves fall in the other three tribal districts. The depth of the water table (DTW) in the seven districts ranged from 5 to 150 m (Asian Development Bank, 2014). The temporal analysis (ADB and FDA, 2010; ADB, 2014; PCRWR and IUCN, 2018) shows that population growth along with climatic vulnerability has increased the dependence on groundwater as reliable source of drinking water, especially in the urban areas. As seen in previous chapters of this publication, climate change has not only influenced rainfall patterns but also caused the intensification of rainfall events with a shrinking of wet periods. In mountainous areas, increased runoff triggers flash flooding and reduces groundwater recharge. Thus, both climate change and overuse are contributing to increasing groundwater depletion and a significant lowering of the water table by an average 70 m. As a result, many water supply schemes in KP province are no longer functioning (thethirdpole.net, 2015). Early and longer summer spells with higher day temperatures, especially over the past decade, have also led to increased drinking water consumption and the drying of many springs in the districts of Khyber and Mohmand (ADB, 2014).

Overall, almost all (97%) groundwater sources in the merged districts and 63% in the frontier regions were found unsafe for drinking, mainly due to bacterial contamination. The situation was found worst in Mohmand district.

The latest study on groundwater in KP was conducted for Peshawar valley aquifer covering Peshawar, Charsadda, Mardan, Nowshera and Swabi districts (PCRWR and Helvetas, 2019). The aquifer mainly consists of alluvium deposits such as gravel, boulders, sand, and clay. It is deepest in the centre of the valley, tapering to become closest to the surface in the Northeast in the area of Gadoon, Swabi. The overall variation in the water table depth of Peshawar valley ranges from 1.5 to 91 m. The shallow water table depths, generally less than 10 m, indicate a slow pace of groundwater development. The greatest groundwater depletion was recorded in urban centres, especially in Peshawar city where groundwater depth has dropped to 46 m, and 91 m in the industrial area of Hayatabad. Across some 97% of the area of Peshawar Valley, the groundwater is of usable quality (0-2.5 dS/m) for drinking and irrigation. However, in a few places, mainly at Risalpur in Nowshera district, groundwater salinity is high, ranging from 2.6 to 4.8 dS/m. Moreover, it has been estimated that the active storage of usable groundwater is about 97 MAF, down to a depth of 300 m. Isotopic studies have shown that most of the area is being recharged through a mixture of river water and rainfall sources.

The same study shows an average depletion of about 6.5 m over the 30-year period from 1985-2015. This means that groundwater is dropping at an average annual rate of about 0.21 – 0.7 m across different locations. The study estimates an average annual groundwater storage loss of about 4.1-7.4 MAF in Peshawar valley against annual surface recharge of about 10.7 MAF. The study further shows that the groundwater depletion rate is higher in urban areas such as Peshawar City including Hayatabad due to heavy extraction by pumping. It is particularly high in Hayatabad, which includes the industrial area, where modelling estimates that groundwater is depleting at an average annual rate of about 1.42 m. The assessment shows that about 23.64 MAF of groundwater potential is available up to the depth of 300 meters for abstraction in Peshawar Valley. Moreover, it is a high yielding aquifer and groundwater is a major component of water balance of KP. However, the surface water from the canal discharges is calculated about 5.2 MAF annually. Keeping in view the undulating topography of Peshawar valley, the surface water conveyance efficiency is assumed as 52%. It means that surface water resource of about 2.71 MAF is actually available at farm gate. The water demand and availability analysis reveal that overall water resource potential of about 26.35 MAF (surface plus groundwater) is available against total demand of about 2.96 MAF. Resultantly, a total balance of 23.4 MAF of water resource potential is available for further exploitation but efficient utilization through effective management is also important for its future sustainability.

Peshawar valley's assessment of groundwater concludes that plenty of freshwater resources are available and there is not yet an alarming situation in any of the districts excepting Peshawar itself (especially in Hayatabad and industrial area). This information confirms concerns highlighted in Chapter 8, where water use by industry is discussed. For the rest of the valley, the groundwater situation is almost stable in terms of the quality and quantity of groundwater. Nevertheless, this resource needs to be regulated, and efficient irrigation practices and conservation measures adapted, to ensure long term sustainable use. If unchecked, the rising number of tube wells in the valley could lead to future problems.

To conclude, beyond Peshawar valley, the other parts of KP province in which there is concern over groundwater reserves in terms of depletion and deterioration of water quality are the districts of Karak, Bannu, Lakki Marwat, Haripur, Bajaur, Khyber, and Mohmand.

6.5 Hydrological balance

An analysis of water balance within the province has not been conducted until now. For this analysis, data on water use and water losses has been taken from the provincial status reports prepared by various government departments for the development of a provincial Integrated Water Resource Management (IWRM) strategy. In the case of missing figures, out-take losses including evaporation percentage, system recharge and return flows have been estimated according to the proportions used by MacDonald et al., 2016 and Young et al., 2019.

An accurate assessment of groundwater use in KP province is also missing. For this assessment, data on total known groundwater extraction through tube wells has been used as proxy data to calculate the total extraction of groundwater. This calculation does not include tube wells which may be unofficial or not recorded by any authority.

The following sections provide more details on water use by various sectors. For readers' convenience, the figures used in this analysis have been combined in one place: Table

6.5 whereas Figure 6.2 presents water balance of KP in graphical form.

6.5.1 Surface water resources

System intakes

1. Total water provided to KP under the Provincial Water Accord: 5.97 MAF[20]
2. Surface run-off / rainwater harvesting potential: 3.71 MAF[21]
3. Surface water potential in the tribal districts: 3.99 MAF[22]
4. Water potential from *Rudh Kohi* system: 2.47 MAF[23]
5. Water supplied from canals out of the Indus command area: 1.24 MAF[24]

   Total: 17.38 MAF

System offtakes

Use of freshwater for agriculture: 90%[25] - 15.64 MAF

- o Used by Crops: 43% of total water supplied to agriculture including livestock: (6.73 MAF)[26]
- o Remaining 57% is lost into the hydrological system – 8.91 MAF
  - ▪ 14% conveyance losses from canals and water courses (estimated) 2.19 MAF
  - ▪ 22% evaporation losses in the atmosphere (estimated): 3.44 MAF
  - ▪ 9% system recharge / aquifer recharge (estimated): 1.41 MAF
  - ▪ 12% return flows (estimated): 1.87 MAF

Non-agricultural uses of surface water: 10% (1.74 MAF)

- o Total use for domestic consumption 46.5%[27]: 0.81 MAF
- o Estimated use by commercial entities 2.5%[28]: 0.04 MAF
- o Total losses (estimated wastewater, overhead tank losses, misuse) 42%[29]: 0.73 MAF
- o System recharge / aquifer recharge (estimated) 9%: 0.16 MAF

20 Out of the total water 8.78 MAF accorded to the province, 2.81 MAF goes to outflows due to unavailability of infrastructure, leaving 5.97 MAF to KP. Based on data available with Irrigation department, 2019 (Khan, 2019b)

21 Helvetas, 2019 (Chapter 5). It does not include rainwater infiltration and downpour feeding rainfed agriculture.

22 Based on PCRWR and IUCN, 2018. Assessment of Water Resources in FATA.

23 Based on GoP 2017. National Food Security Policy (Draft). The untapped potential of about 19 MAF generated from hill-torrents (Rudh Kohi), if harvested, may bring about 7 million-hectare area under cultivation in Balochistan (67%), KP (13%), Punjab (8%), Sindh (8%) and Federally administered areas (4%)

24 Based on Khan, 2019b. Provincial Status Report Hydrology. Government of KP.

25 Based on Zulfiqar et al., 2019. Provincial Status Report Agriculture, Government of KP. GoKP 2020, IWRM Strategy, Government of KP.

26 The proportions 43:57 and further breakdowns based on Macdonalds et al., 2016 (*Nature Geosciences* 9: 762–68) and Young et al., 2019 (World Bank, Washington, DC).

27 Zia, Khattak and Muhammad, 2019. Provincial Status Report Drinking Water and Sanitation. Government of KP.

28 Based on UNDP, 2016.

29 Zia, Khattak and Muhammad, 2019. Provincial Status Report Drinking Water and Sanitation. Government of KP.

6.5.2 Groundwater resources

System intake

The groundwater extraction for agriculture is 3.4 MAF, and for domestic purposes 0.57 MAF (in both cases, excluding the tribal districts). In the tribal districts, total groundwater withdrawal is 0.117 MAF, of which the segregated figures for agriculture and domestic are not known. It is assumed that due to the absence of a well-organised irrigation system, half of the groundwater resources in these districts are used in agriculture to meet irrigation requirements.

System offtakes

Groundwater is used to manage the water demand for crops when surface water is insufficient.

Use of groundwater for agriculture

Total withdrawal for agriculture is 3.46 MAF including 0.06 MAF from the tribal districts.

- Arable: 57%[30] of total water supplied to agriculture including livestock: (1.97 MAF)
- Remaining 43%[31] is lost into the hydrological system – 1.49 MAF – as follows:
  - 22% evaporation losses in the atmosphere (estimated): 0.76 MAF
  - 9% system recharge / aquifer recharge (estimated): 0.31 MAF
  - 12% return flows (estimated): 0.42 MAF

Use of groundwater for non-agricultural purposes

The current withdrawal of groundwater for domestic purposes is reportedly 0.63 MAF including 0.06 MAF from the tribal districts)[32].

- Total consumed in domestic uses 46.5%[33]: 0.29 MAF
- Estimated use by commercial entities 2.5%[34]: 0.016 MAF
- Total losses (estimated wastewater, overhead tank losses, misuse) 42%[35]: 0.27 MAF
- System recharge / shallow recharge (estimated) 9%: 0.057 MAF

30 43% of surface water (canals) reaches crops. We have, however, taken an additional 14% in this proportion since conveyance losses in case of use of tube wells are minimal when compared to irrigation through canals.

31 The proportions are based on MacDonald et al., 2016 (*Nature Geosciences* 9: 762–68) and Young et al., 2017 (World Bank, Washington, DC)

32 Zia, Khattak and Muhammad, 2019. Provincial Status Report on Drinking Water & Sanitation. Government of KP

33 Ibid

34 Based on UNDP, 2016

35 Zia, Khattak and Muhammad, 2019. Provincial Status Report Drinking Water and Sanitation. Government of KP.

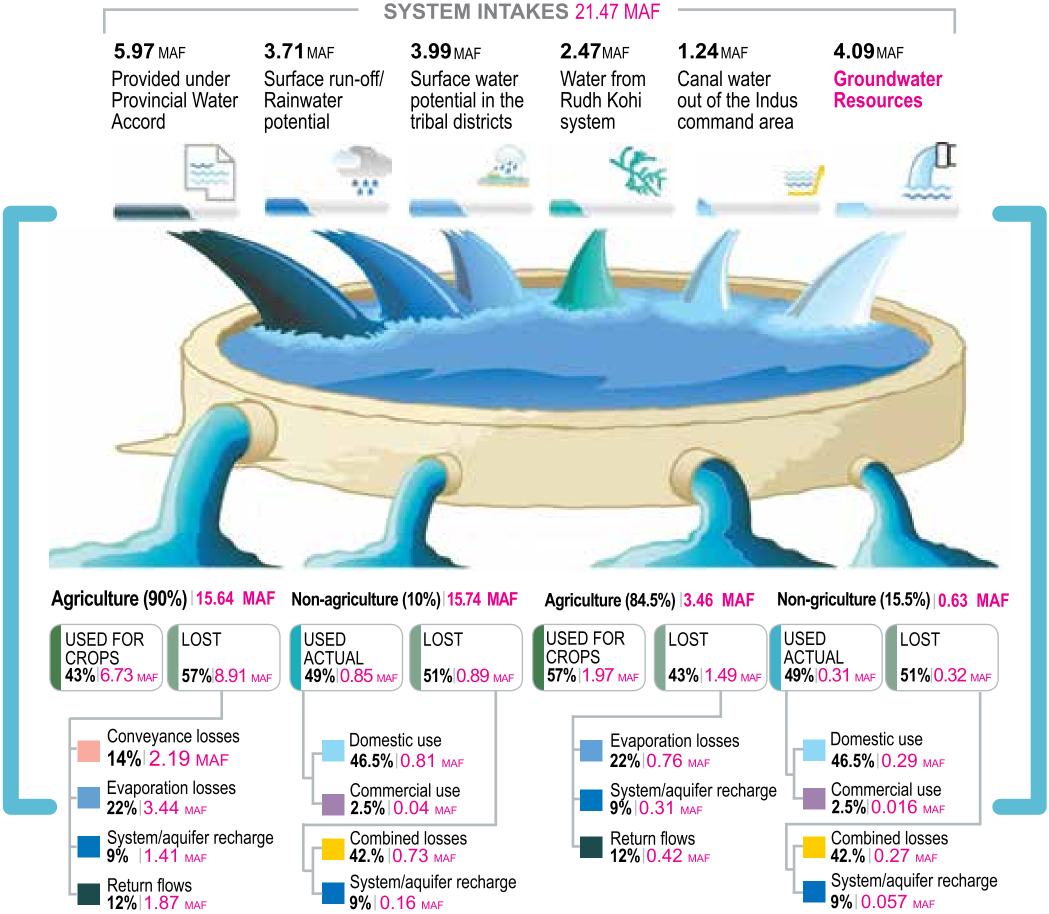


Figure 6.2. Hydrological Balance of KP

Table 6.5. Summary of data sources used for calculating KP province water balance

Data	Calculation	Data source
Total provincial water share from the Indus River	8.78 MAF	Water Apportionment Accord, IRSA, Government of Pakistan 1991.
Total water share utilised	5.97 MAF	Irrigation Department, 2019 (Khan, 2019b)
Outflows due to unavailability of infrastructure	2.81 MAF	Irrigation Department, 2019 (Khan, 2019b)
Rainfall potential	3.71 MAF	Calculated by Helvetas (metric system) = 74.12 MAF 5% will be used for crops under rainfed conditions or through small rainwater harvesting structures. The remaining will join aquifers and water bodies.
Surface water potential in tribal districts	3.99 MAF	Status report Hydrology (Khan, 2019a)
Rudh Kohi potential	2.47 MAF	National Food security policy (19 MAF total *Rudh Kohi* potential of the country of which 13% lies in KP)
Water from four of the Indus canals	1.24 MAF	Based on Khan, 2019b. Provincial Status Report Hydrology. Government of KP
Water for crops	90%. Used: 43%, Lost: 57%	Based on status report water productivity (Jan and Khattak, 2019) and status report agriculture (Zulfiqar et al., 2019)
Conveyance losses Evaporation System recharge Return flows	14% 22% 9% 12%	Based on Macdonalds et al., 2016 and Young et al., 2019
Industrial uses	2.5% for the country. Same figure has been applied as a proxy for KP since the figure for KP does not exist	Based on UNDP, 2016
Groundwater KP province	3.4 MAF for agriculture 0.57 MAF for drinking	Based on data from Agriculture, Public Health Engineering and Local Government Departments (2019) Based on Status report groundwater (Khalil, Wazir and Muhammad, 2019)

Groundwater tribal districts	Total groundwater potential: 0.117 MAF	Based on PCRWR and IUCN, 2018
Breakdown of groundwater withdrawal from tribal districts between drinking and irrigation	Divided as 50:50 since there are no systematic data on tube well irrigation in tribal districts	Total withdrawal of groundwater for drinking from water schemes is known (0.06 MAF), which is 50% of the total withdrawal of 0.117 MAF
Water consumed at domestic level (not returning to the system)	49% of the total groundwater withdrawal (0.31 MAF)	Based on status report on drinking water & sanitation (Zia, Khattak and Muhammad, 2019). The discharge and operating time of tube wells has been considered for calculation of groundwater extraction
Domestic losses	51% Returns / recharge	Estimated based on selected data collection from overhead tanks and households (this is water mostly eligible for recycling)
Return flows	12% agriculture	Based on Young et al., 2019
System recharge	9% Assumed same for domestic and agricultural sector	Based on Young et al., 2019

Water losses continue even after water is converted into crops. In Pakistan post-harvest crop losses are estimated at 35-40 percent. (Abbas et al., 2019). Loss of crops means loss of water productivity. Pakistan could save about $1.13 billion annually by reducing up to 75% of post-harvest losses (ADB, 2019)[36]. In addition, an estimated 36 million tons of food is wasted in Pakistan every year (Mughal, 6018). This comes to 0.17 tons of food wasted per person per year (COMCEC, 2016).

Per capita availability of water has dropped to below 1,000 m^3 from above 5,200 m^3 in 1947, making Pakistan a water scarce country. (GoP, 2018b; GoP,2018c). The total annual surface water available in Pakistan is 145 MAF for a population of 207 million, equivalent to about 860 m^3 water per capita. The major contributing factors for this drastic decrease are rapid population growth and wasteful usage of this precious finite resource.

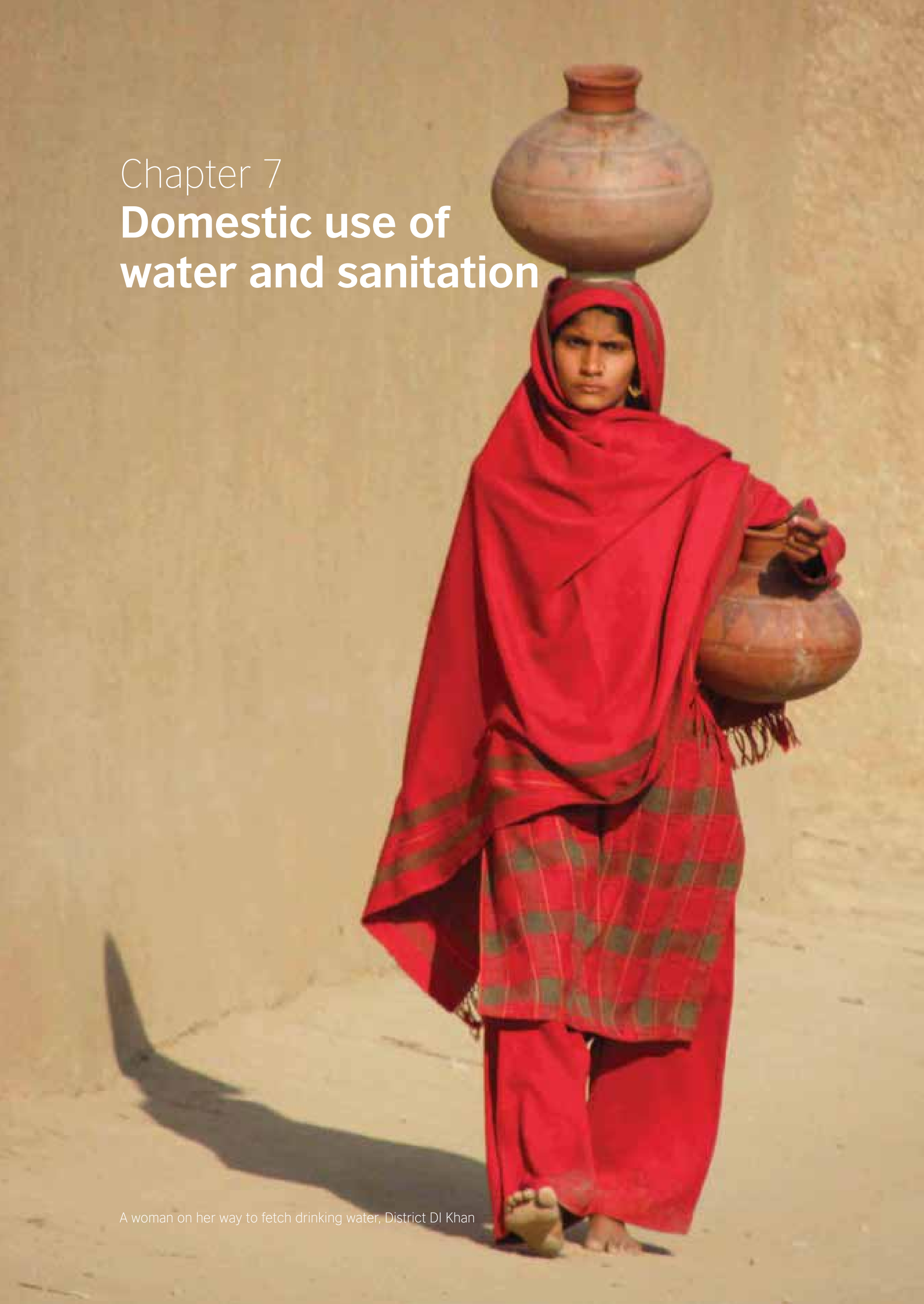
Compared to the national average, KP province's total per capita freshwater availability is only 760 m^3 after calculating all available water sources including the IRSA allocation, surface water from other sources and the current annual abstraction of groundwater. This contrasts with the general perception that KP is a water rich province. Nearly 32%[37] of the province's geographical area falls under arid and semi-arid conditions with

36 Also reported in https://www.dawn.com/news/1515596 accessed 8th November, 2019.
37 Chapter 1, Table 1.3

little agriculture and industry, with nearly 31% population of the province living within this area. The entire water use pressure converges in the remaining area which is also the central hub of agriculture, industry, and domestic use.

The hydrology of KP province shows ample potential for out of the basin solutions including harvesting *Rudh Kohi* floods in the south and rainwater collection in small dams. This will contribute to increasing the irrigated area without changing the provincial water share or making huge infrastructure investment. Harnessing this potential needs to be coupled with sustainable water resource management strategies. Water efficiency and productivity are needed even at a time that resources appear to be ample, given the unpredictability caused by changing climate, the vulnerability of the province to disasters, and the fast increasing population. Moreover, the groundwater legislation and development of regulatory framework are very critical as a future direction of investment to ensure resource sustainability.

Chapter 7
Domestic use of water and sanitation



A woman on her way to fetch drinking water, District DI Khan

Chapter 7
Domestic use of water and sanitation

Mohsin ul Mulk
Khan Mohammad
Behramand Khan

Pakistan ranks number nine in the list of top ten countries of the world with the lowest access to clean drinking water close to home; 21 million people out of the total population of 207 million do not have access to clean water (Wheeler et al., 2018). Nevertheless, the country has made the significant achievement of providing access to clean water for an additional 44 million people since 2000 (ibid). There remain huge disparities. Almost all people in the middle and high-income population groups have access to clean water close to home whereas one in five people living in poverty do not. All relevant policy documents reflect that Pakistan recognises accesses to potable water as a basic human right and is committed to providing potable water to all its citizens (Vision 2025, National Water Policy 2018).

In KP province, several steps have been taken to improve the governance of water, sanitation and hygiene (collectively known as WASH) in line with the national water sector policies and the global commitment to the SDGs. The following section discusses the role of various government departments and other organisations regarding the provision of water to the population for domestic purposes.

7.1 Rural water supply by Public Health Engineering Department (PHED)

The PHED remains the most important player in the provision of domestic water in rural areas, currently catering to the needs of 68% of the population in this respect. Table 7.1 gives a district wise summary of the population served by PHED in 25 districts in 2019.

Table 7.1. District wise summary of the population served by PHED schemes in KP province

S. No	Districts	Rural Population (Census 2017)	PHED Coverage 2019		% age of Population Served
			Number of Schemes	Population Served	
1	Bannu	1,161,041	422	753,493	65%
2	Lakki	813,121	455	529,885	65%
3	DI Khan	1,333,457	267	952,446	71%
4	Tank	381,109	122	242,800	64%
5	Abbottabad	1,039,775	357	873,125	84%
6	Battagram	476,612	119	296,370	62%
7	Haripur	876,454	213	709,850	81%
8	Mansehra	1,411,605	314	1,310,313	93%
9	Torghar	171,395	42	66,127	39%
10	Kohistan	784,711	229	373,468	48%
11	Hangu	416,358	93	285,000	68%
12	Karak	655,150	466	428,276	65%
13	Kohat	842,306	168	800,630	95%
14	Mardan	1,933,736	242	1,841,122	95%
15	Swabi	1,348,691	191	973,550	72%
16	Charsadda	1,346,023	164	1,084,000	81%
17	Nowshera	1,179,890	208	1,115,120	95%
18	Peshawar	2,363,728	344	1,240,386	52%
19	Buner	897,319	200	419,744	47%
20	Chitral	397,568	211	228,285	57%
21	Shangla	757,810	194	378,600	50%
22	Swat	1,613,670	331	1,492,990	93%
23	Lower Dir	1,395,544	239	892,057	64%
24	Upper Dir	902,256	107	339,293	38%
25	Malakand	652,095	180	422,623	65%
Total		**25,151,424**	**5,878**	**18,049,553**	**68%**

Source: Public Health and Engineering Department, Government of Khyber Pakhtunkhwa, 2019

In the newly merged districts, the PHED had completed 1,977 drinking water schemes by 2019 – reaching 57% of the population. This means that 43% of the population remains to be served (Table 7.2). In a few cases, the supply gap is higher than 50%. To obtain full coverage, around 2,000 more schemes of similar size to those currently being installed may be required (Zia, Khattak and Muhammad, 2019). Figure 7.1 presents the percentage of the population served by PHED in KP province, including the newly merged districts.

Table 7.2. Total population covered by PHED schemes in tribal districts

Name of tribal district	Rural Population (Census 2017)	Population served	% Coverage
Bajaur	1,093,684	572,010	52%
Mohmand	466,984	322,428	69%
Khyber	889,433	646,647	73%
Kurram	579,556	284,217	49%
Orakzai	254,356	184,471	73%
N. Waziristan	538,893	309,775	57%
S. Waziristan	679,185	228,135	34%
Total	**4,502,091**	**2,547,683**	**57%**
Source: Zia, Khattak and Muhammad, 2019			

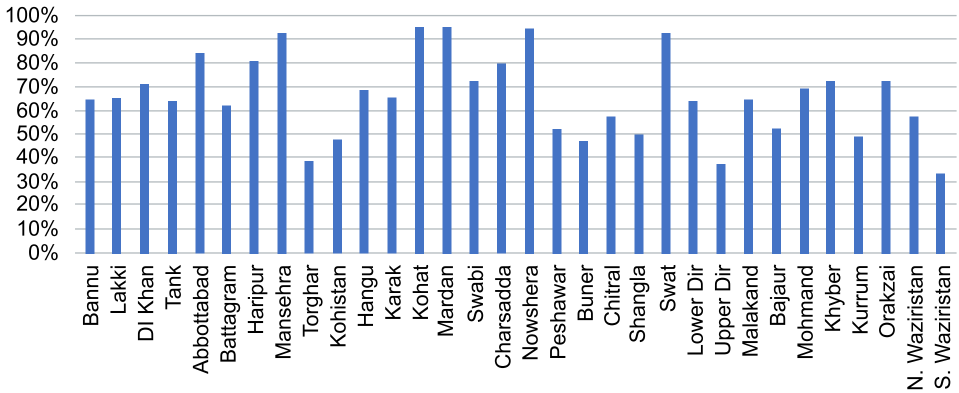


Figure 7.1. Percent of the population in KP supplied with drinking water by PHED
Source. Data received from PHED (2019)

According to 2019 data, 82% water supply schemes were operational whilst the remaining 18% were either poorly functional or defunct. The systems are mostly pump-based (71%) using grid electricity (67%) or solar energy (4%). The rest (29%) are gravity system designs. In the newly merged districts, 76% schemes are pumped (32% using grid electricity and 44% solar power), whilst 24% use gravity flow.

The water sources feeding these schemes are of five types: a) tube wells; b) springs; c) dug wells; d) infiltration galleries; and e) surface water. Figure 7.2 shows that most water sources are tube wells; these account for 72% of schemes, followed by 22% from springs. The remaining schemes (6%) are fed by dug wells, infiltration galleries and surface water sources.

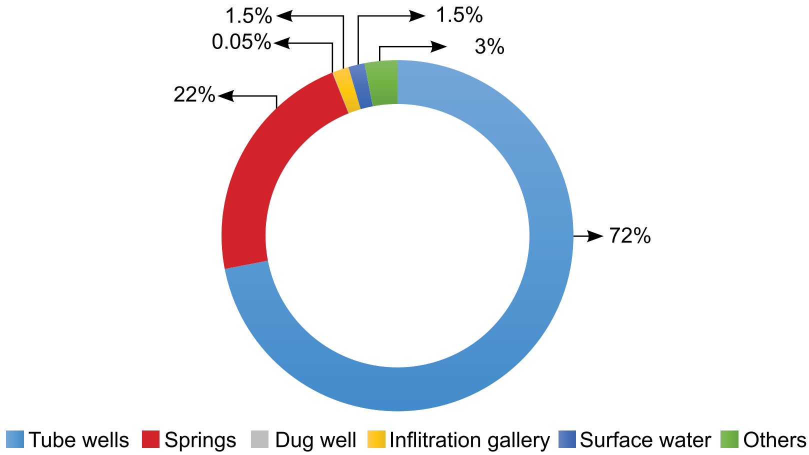


Figure 7.2. Type of sources of PHED Schemes

7.2 Urban water supply by Water & Sanitation Services Companies (WSSCs)

Figure 7.3 provides data on the services of WSSCs in seven major towns of the province in 2019. Peshawar is clearly the most densely served, with around 506 schemes, followed by 56 in Kohat, 50 in Abbottabad, 25 in Mardan, 20 in Bannu and 3 in DI Khan.

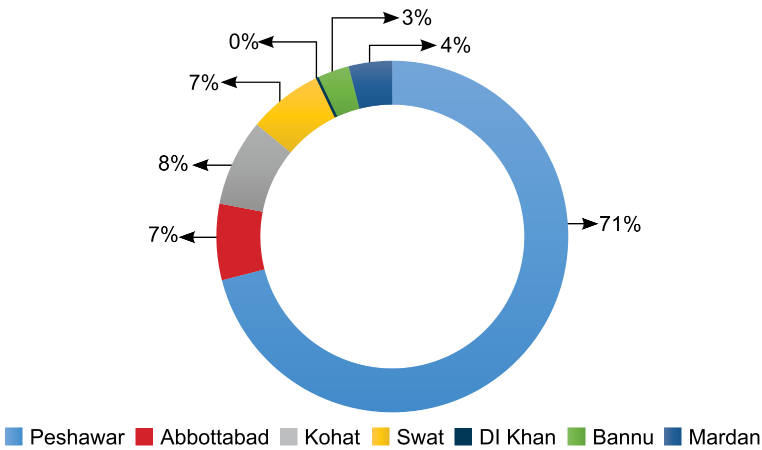


Figure 7.3. Coverage under the WSSC schemes

The overall proportion of non-functional drinking water schemes run by WSSC is only 6%. These schemes are almost 100% reliant on grid electricity; none use solar power and only two use gravity flow.

Table 7.3. Population coverage of WSSCs in seven urban centres

District	Total Urban Population	Population Covered	Percentage
Peshawar	1,970,042	1,700,000	86%
Abbottabad	293,137	90,856	31%
Kohat	270,146	270,146	100%
Swat	695,900	Data not available	
DI Khan	362,231	Data not available	
Bannu	49,965	42,955	86%
Mardan	439,325	375,433	85%
Total	**4,080,746**	**2,479,390**	**60.75%**

7.3 Urban water supply through Tehsil Municipal Administration

The Tehsil Municipal Administration (TMA) is the second tier in the existing local government structure. The number of TMAs within a district varies according to the area and population density. The KP province Local Government Act, 2014 entrusts TMAs with responsibility for providing drinking water, sanitation, and solid waste disposal services within their respective jurisdictions. Out of the total 49 schemes in the eight TMAs selected for this analysis, groundwater is the main source for all but one (thus for 96% of them). Similarly, grid electricity is the main source of energy for powering 48 of the schemes, the remaining one using gravity flow. In total some 335,550 people receive drinking water supplied by these schemes in KP province.

7.4 Overall situation of drinking water

The combined data for water schemes in KP province managed by PHED, TMAs and WSSCs shows that out of a total 8,667 drinking water supply schemes, 87% are operational, 12% are non-operational, and approximately 1% are in progress. Regarding their source, 75% are fed from groundwater by tube wells, 21% are fed from springs, 0.04% by dug wells, 1% from infiltration galleries, 1% from surface water and 2% from other sources. Most schemes, 62%, depend on grid electric power supply; 25% operate by gravity flow, whilst 13% are run on solar arrangements.

In total, 23.41 million people (65% of the total population) are supplied with drinking water through the 8,667 schemes managed by PHED, WSSCs and TMAs. A summary of the population served against total population is given in Table 7.4.

Table 7.4. Summary of overall served population against total population

Districts	Total Population (Census 2017)	Population Served by			Total population covered	Population Recorded for More than One Actor	% of Total Population served	% of Total Population unserved
		PHED	WSSC	TMAs				
KP districts including newly merged FRs	30,881,058	18,049,553	2,479,390	335,550	20,864,493	200,044	67%	33%
Newly merged districts	4,643,989	2,547,683	-	-	2,547,683	-	55%	45%
All Districts	35,525,047	20,597,236	2,479,390	335,550	23,412,176	200,044	65%	35%

The discharge and operating time of tube wells has been considered for the calculation of groundwater extraction. Taking an average extraction of 6,000 gallons/hour and an average operating time of six hours per day, the total extraction of groundwater through tube wells is approximately 234,720,000 gallons/day[38]. This comes to a total of 85,673 million gallons or 0.263 Million Acre Feet per year. Of this, the share of newly merged districts is 23%.

7.5 Sanitation services

Environmental cleanliness, household sanitation and personal hygiene are essential for ensuring the health of the population, as are awareness of the use of safe water, latrines, and of the preparation of hygienic food. In 2015, 61% of the global population (4.5 billion people) had poor access to safely managed sanitation services (WHO, 2017). SDG 6.2 aims to ensure access to adequate and equitable sanitation and hygiene for all and to end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations. SDG 6.3 focuses on the improvement of water quality by reducing pollution, eliminating dumping and minimising the release of hazardous chemicals and materials, halving the proportion of untreated waste-water and substantially increasing recycling and safe reuse. Concerning these two sub-sets of SDG 6, the current state of sanitation in Pakistan is as follows (WSP, 2007; GoKP, 2016b; UNICEF, 2020):

- 60% waste in Pakistan remains un-collected.
- 1 in 10 people practices open defecation.
- 93% wastewater remains un-treated.
- 42% of the population is without basic sanitation.

38 The basis of calculations: 6 hours per day * 6,000 gallons per hour * 6,520 tube wells = 234,720,000 gallons

The impact of this dismal situation is that:

- 110 children under the age of five die every day due to poor sanitation (39,000 children every year)
- 3 million people are annually hospitalised with waterborne diseases
- 4% of GDP is lost because of sanitation and water related issues.

These facts demonstrate the significance of sanitation. Access to improved sanitation is fundamental to leading a dignified life, vital for health protection and enables access to education and work opportunities. Poor sanitation directly impacts human health, particularly that of children and women. The economic cost of poor sanitation is PKR. 343.7[39] billion which is 3.94% of the GDP (WSP, 2007).

The National Water Policy, 2018 calls upon the provinces to formulate detailed policies within the broad parameters of water security as all citizens of Pakistan have the right to equal and affordable access to clean drinking water and appropriate sanitation facilities. The policy also calls for full financial sustainability of urban water and sanitation systems at affordable rates. Industrial units and municipal entities are required to treat hazardous effluents before disposal. The KP province Drinking Water Policy, 2015 identifies inadequate sanitation as a major threat to surface and ground water and calls for an integrated approach towards the drinking water and sanitation sub sector.

As a whole, sanitation and solid waste management systems need major improvement in the province to protect the health of people at risk. Out of the total sanitation schemes constructed by PHED, only 6% have a good physical standard, 50% are considered of average standard, whilst the remaining 44% are in very poor condition (Figure 7.4). In the WSSC operating areas, there are 29 schemes to date, of which 26 are functional. WSSCs are based on public-private partnerships and are, therefore, generally better maintained.

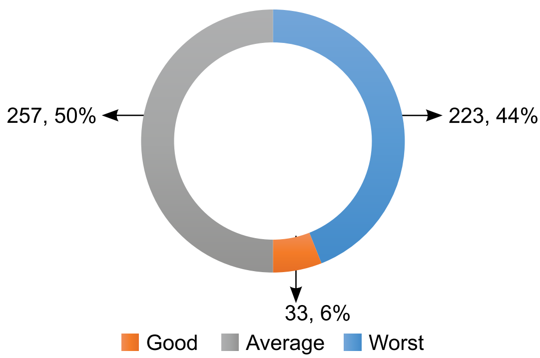
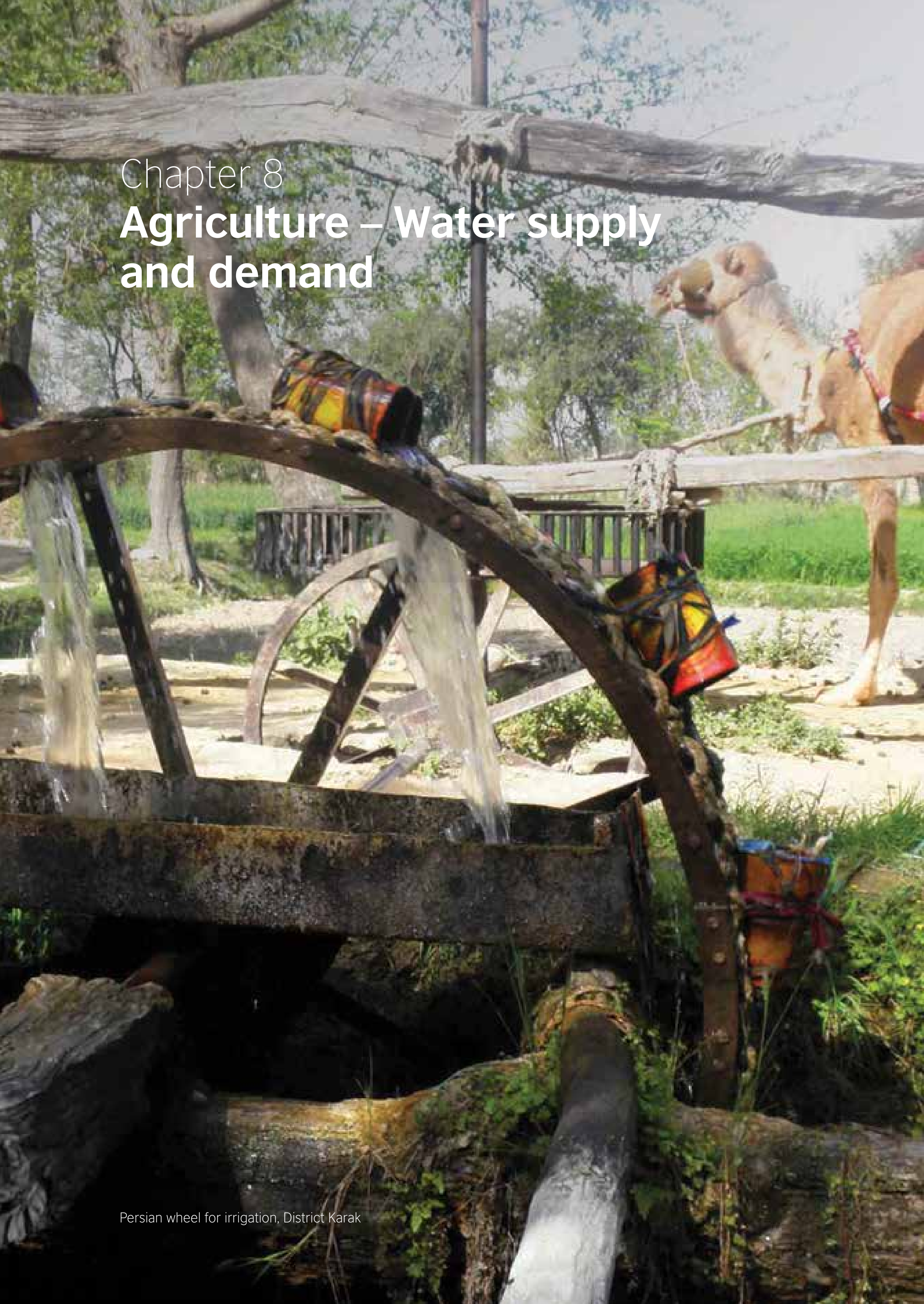


Figure 7.4. Physical status of PHED sanitation schemes

39 (1 USD = 155 PKR). Source: tps://www.bing.com/search?q=usd+pak+rupee+exchange+rate

Chapter 8
Agriculture – Water supply and demand



Persian wheel for irrigation, District Karak

Chapter 8
Agriculture – Water supply and demand

Muhammad Zulfiqar
Behram Jan
Munawar Khan Khattak
Murad Ali Khan
Muhammad Arif Kakakhel

As an agrarian country, water is the lifeline of Pakistan's economy – and agriculture consumes a significant share of the available water. Agriculture contributes 18.5% to the country's Gross Domestic Product (GDP) and provides 38.5% employment to the national labour force (GoP, 2019b). Pakistan's finite water resources must be managed in a manner that allows enough water for domestic use, food production, industrial development and the protection of ecosystems.

As previously noted, about 83.5%[40] of the total population of KP province live in the rural areas and mainly earn their livelihood from agriculture (GoKP, 2015a). Agriculture plays an important role in the provincial economy by contributing 24% to the provincial GDP and accounts for half of the employed labour force (GoKP, 2019b). Crops account for about 70% of agricultural sector production by value, with the most important crops being wheat (22% of total value), maize (18%), sugarcane (13%) and tobacco (9%), with the livestock sector accounting for the remaining 30% (GoKP, 2015a). The total count of livestock in the province is some 21.18 million[41] (GoP, 2017b; GoKP, 2019b). The settled districts also report more than 21 million head of poultry (GoKP, 2019a). Most of the main crops other than wheat are highly water demanding. Figures 8.1 and 8.2 provide an overview of the *Rabi* (winter) and *Kharif* (summer monsoon) cropping intensities respectively, (GoKP, 2015; Nizami et al., 2020).

[40] GoP, 2018b
[41] Settled districts 14.63 million (2017) and newly merged districts 6.55 million (2016)

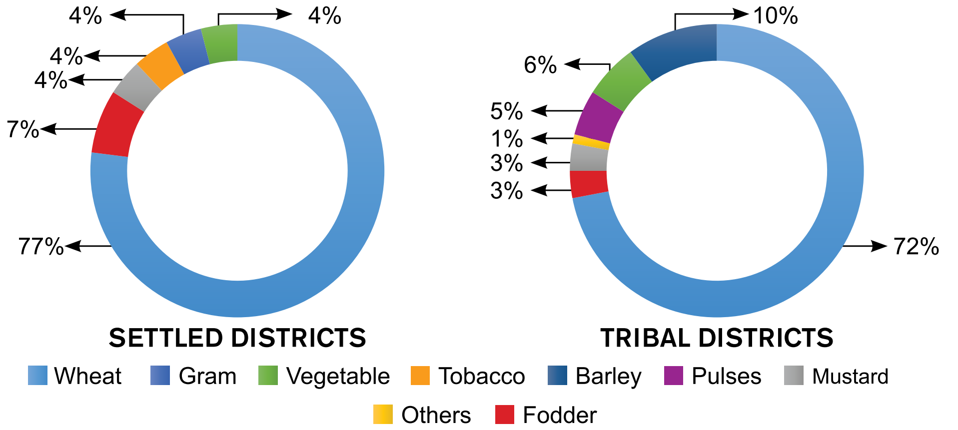


Figure 8.1. Rabi cropping pattern in KP province

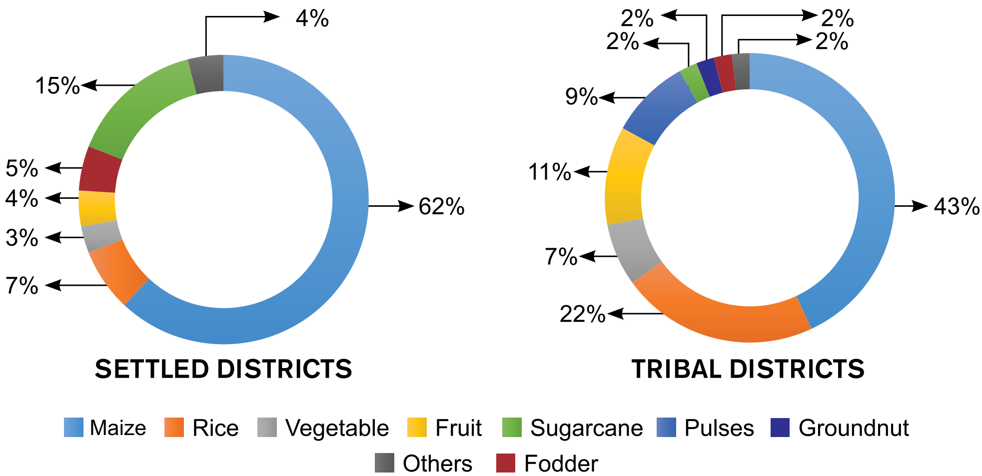


Figure 8.2. Kharif cropping pattern in KP province

Nationally, Pakistan has a geographical area of 80.404 million ha or 796,096 km^2, out of which 29.42 million ha (36.59%) is cultivatable and 21.17 million ha (71.96%) is currently cultivated. The irrigated area is 17.82 million ha, amounting to 60.67% of the cultivatable land. This compares with only 34% of KP province's cultivated area being irrigated (0.92 million ha) while 66% (1.80 million ha) is rainfed (Khan, 2019a). With almost two thirds of its cultivated land depending on rainfall and a large proportion of cultivable waste land, a shortage of water for irrigation and domestic purposes appears to be one of the most critical factors contributing to the multidimensional poverty of KP province.

Livestock drinking requirements are also met out of the share of water for agriculture but often are not included in calculations. If livestock requirements are added, they amount to some daily one billion litres, rendering the water shortfall for agriculture even greater. The current trends of water shortage and rapidly competing demands will result in agriculture becoming increasingly unsustainable, with food production insufficient to meet the demand of the growing population. Given the current very high water losses of 43-53%, there is potential to improve the situation through improved water governance and improved water efficiency. New strategies are needed for irrigated agriculture to enhance input efficiency at the same time maintaining and improving the quality of the resource base. Figure 8.3 shows that our consumption is much higher than our production (Jan and Khattak, 2019). Therefore, the real challenge is to manage the available water resources to increase productivity rather than focusing on matters of adequacy or scarcity.

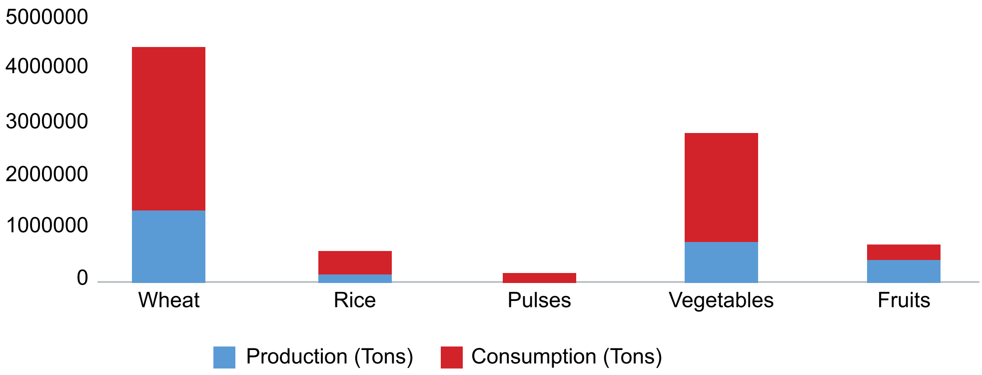


Figure 8.3. Production and consumption data of selected crops

8.1 Water productivity gap in agriculture

Water productivity is a plausible option for quantifying sustainable water use in agriculture and thereby proposing suitable economic policies to ensure intelligent and informed water allocation for crops in a manner that meets present demand without overlooking the needs of future generations. Water productivity is an important element in improved water management for sustainable agriculture, food security and healthy ecosystem functioning. A comparison of crop yields between KP province and Pakistan suggests considerable room for improvement. For example, the yield of wheat in KP province is only 62% of the national yield and 61% of the Punjab[42], where the wheat yield is the highest amongst the four provinces. Average levels of water productivity in KP province are quite low when compared to yields obtained by global, regional and national levels.

[42] Agriculture statistics of Pakistan 2013-2014.

At present in KP province about 1,351 litre water is used to produce 1 kg wheat; 1,136 litres for 1 kg maize; 4,348 litres for 1 kg rice; and 250 litres for 1 kg sugarcane. National averages for the same crops are 1,087 litres water to produce 1 kg wheat; 877 litres for 1 kg maize; 1,639 litres for 1 kg rice and 87 litres for 1 kg sugarcane[43]. Both provincial and national figures compare unfavourably to average global production figures, which are 917 litres water for 1 kg wheat; 556 litres for 1 kg maize; 917 litres for 1 kg rice, and about 153 litres for 1 kg sugarcane, respectively (Zwart and Bastiaanssen, 2004; Sharma et al., 2018). These figures indicate that there is potential to improve water use efficiency and water productivity in KP province. The analysis presented in Figure 8.4a and 8.4b indicates huge production gaps for major crops in KP province when compared with average production globally and in Pakistan.

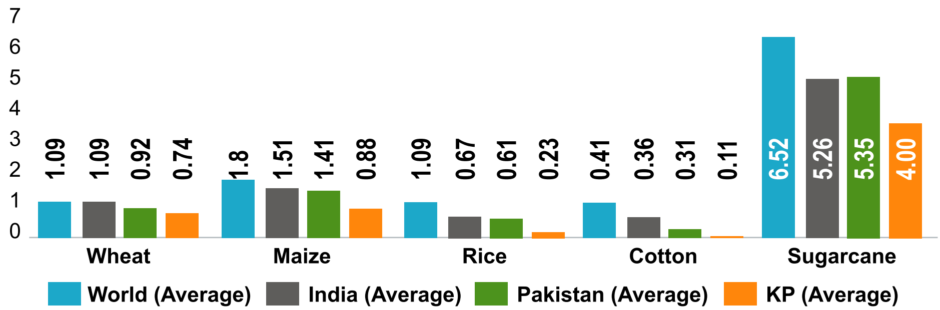


Figure 8.4a. Water productivity gap in KP province (Kg/m^3 of water)

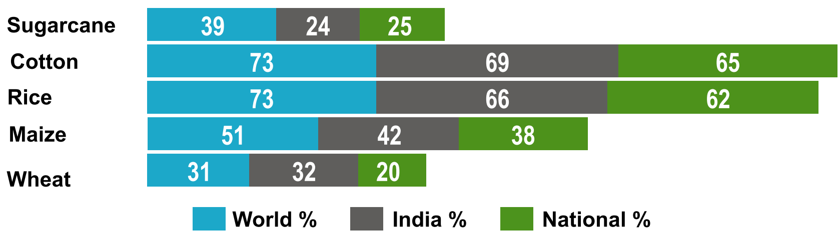


Figure 8.4b. Water Productivity gap in KP Province (%). Source: Zwart and Bastiaanssen, 2004; Sharma et al., 2018

For wheat, maize, rice, cotton and sugarcane, the water productivity is lower in KP province by 20% to 73% when compared to world, region and national levels as shown in Figure 8.4. The large crop yield gap reflects potential for increasing crop water productivity by adopting improved irrigation and related production techniques.

43 Integrated Water Management Strategy 2020, Government of Khyber Pakhtunkhwa.

8.2 Land productivity gap in agriculture

The land productivity gap (crop production per unit area) of most of the crops is also very low in KP province as compared to the world and national level progressive farms (Jan and Khattak, 2019). Average yields in KP province are remarkably low compared to yields obtained by national level progressive farms and globally (Figure 8.5).

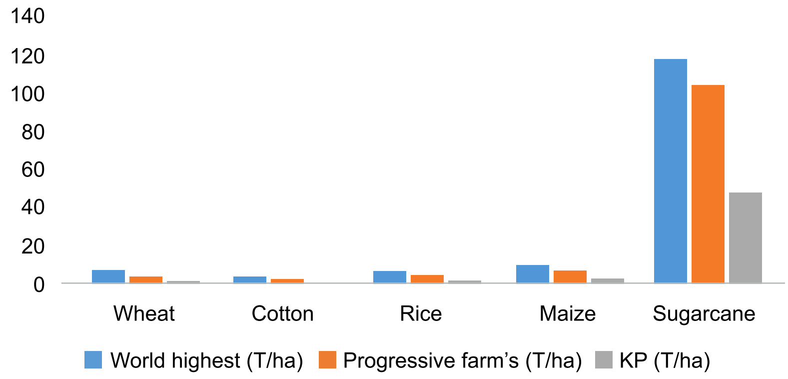


Figure 8.5. Land productivity for selected crops (tonne per ha).
Source: Kamal et al., 2012

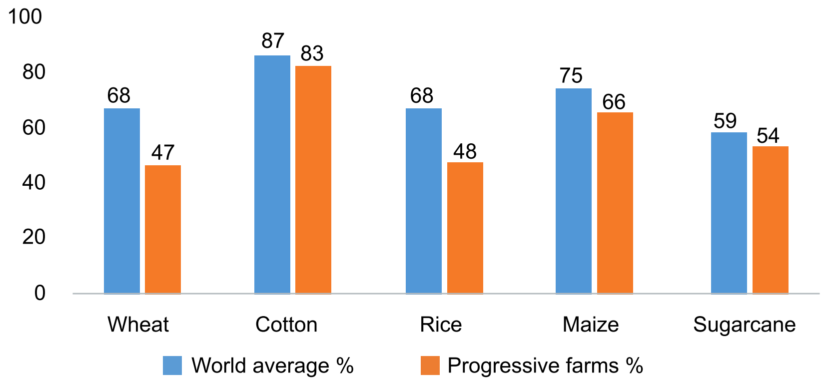


Figure 8.6. Average yield gap compared to world and progressive farms.
Source: Kamal et al., 2012

For selected crops (wheat, cotton, rice, maize, and sugarcane), yields in KP province are lower than world and progressive farms[44] by 59% to 87% and 47% to 83% per unit land area respectively, as shown in Figure 8.6. This reflects the potential to increase crop yield not only through more efficient water management in terms of quantity, but also by overcoming constraints such as poor soil fertility, soil salinity, waterlogging, depletion and soil erosion. Inappropriate agronomic and technical practices as well as the changing climate also contribute to low yield levels. These inefficiencies in land use coupled with institutional constraints serve to reduce the productivity of water.

In most of Pakistan, including KP province, flood irrigation is practiced. In some areas, water efficient techniques such as the use of furrows, beds and basins are applied for the cultivation of vegetables and some other crops. However, the area under improved irrigation practices is small and needs to be increased to save scarce water and to improve per unit water productivity.

8.3 Cropping pattern

The cropping pattern is one of the key factors for improving crop water productivity - needing re-calibration to reduce water demand whilst maintaining revenues through the promotion of high value crops. Temperatures during the *Kharif* season are high, and there are sporadic periods of water scarcity. Water consumption is thus greater than during the *Rabi* season. Options may be explored to enhance the area under *Rabi* crops cultivating high value crops and varieties to exploit the season and save water demand to some extent.

The greatest challenge in the agricultural sector is to produce more food with less water - that is, to increase crop water productivity. There are natural physical constraints to this in KP province given the hilly topography which renders water efficiency difficult to control. Canal water is inequitably distributed and has its own structural and distribution issues. Small land holdings as well as little adaptive capacity among farmers to embrace improved and new agronomic techniques pose additional challenges. Technological innovations that suit small landholdings and the diverse landforms found in KP province need to be promoted and checked for their economic feasibility. For example, in Punjab the relatively larger landholdings and level terrain make it feasible to use laser land levelling. This is not feasible on 60% of the land in KP province due to the topography. Improvements in agricultural practices are further complicated by land fragmentation, lack of access to information, climate change related disasters and poverty. Farmers simply are unable to take risks in disaster prone conditions.

[44] Progressive farms are those where all the best conditions prevail including good extension advice and inputs in Pakistan.

Investments are needed not only to increase irrigation potential through more infrastructure but also to increase efficiency in the conveyance and application of water in the fields. Various strategic policy options exist to enhance water productivity overall, with a special focus on irrigation water productivity. These include improved cropping practices that boost yield; improving the use of rainwater; reducing non-beneficial evapotranspiration; and introducing technologies and practices that improve surface flow and groundwater recharge.

Chapter 9
Use of water by the private sector

A drought prone village of DI Khan

Chapter 9
Use of water by the private sector

Jawad Ali
Arjumand Nizami

The private sector (including the industrial sector, shops, hotels, restaurants, car wash stations and other businesses) is an important stakeholder in the management of water resources. Its significant demand for freshwater, and current competition with other crucial uses of water, needs to be recognised. Meeting the private sector's needs for water is important for the growth of the economy and the generation of employment for millions in the country. Until now, the private sector has been seen only as a water user with hardly any obligations regarding water management; it has not been perceived as a knowledge bearer that can contribute to the sustainable use of water resources, and its participation in this regard has not been sought. Recognising the role of the private sector is important because the challenges of water management are too complex and daunting to be solved by governments alone. Apart from paying for water use, the private sector can invest in sustainable water management, at least at the local level where its operations are directly involved. Such initiatives should seek to improve water use efficiency in production and processing, and to provide technical and financial support to the government for the overall sustainable management of water resources. Around the world, there are many examples of industries that have invested in the provision of drinking water to the communities in areas in which they operate. However, this tends to be informal and is often portrayed as part of corporate social responsibility. Governments have a role to play in negotiating and determining the role of the private sector in water management, especially when this concerns large national and multinational commercial entities. Recent global developments indicate that the private sector is increasingly considered an important stakeholder in the management of water resources, as a potential funding partner and contributor to decision-making, rather than simply a free riding user and polluter.

To enhance the role of the private sector in promoting sustainable water use, it is important that the sector and the government establish a mutually supportive partnership according to a normative framework. Drawing from the example of KP province in Pakistan, this chapter examines the role of the government in building such a partnership and in providing an enabling environment to the industrial sector. For this purpose, the chapter provides a synthesis of the following aspects: the role of the government and the industry in the management of water resources, the type of industry in KP province, the industrial needs for water, current industrial use of water and water treatment practices, and government policies on water management and water treatment. Despite tensions, the KP experience indicates that both types of partners - the government authorities and the industrial sector - are learning how to develop a meaningful partnership for sustainable water management (Nizami, Ali and Khoa-Nguyen, 2020).

9.1 Role of the government in water management

The government's role in promoting sustainable industrial water use must be seen within the overall responsibilities and mandates of the national and provincial governments. National governments around the world are ultimately responsible for providing water for drinking and for irrigation to their citizens. They invest in water and sanitation related activities accordingly. The SDG 6 calls for ensuring availability and sustainable management of water and sanitation for all, water use efficiency, and integrated water resource management. In addition, governments make their own policies and strategies on water management and provide finances and institutional support to implement them. The UN report for 2017 on Global Analysis and Assessment of Sanitation and Drinking Water (WHO, 2017) reported that national budgets for water, sanitation and hygiene (WASH) are increasing at an annual rate of 4.9% as countries seek to address the SDGs. However, discrepancies between global aspirations and national realities exist and 80% of the countries concerned reported insufficient financing to meet even national WASH targets. This makes it difficult to provide the higher-level services needed to achieve the SDGs.

Governments have the responsibility to formulate and oversee regulations and policies within which national systems of water resource management function (Newborne and Mason, 2012). An important function of the government is the allocation of water for multiple, often competing uses and arbitration over the equitable distribution of water. Given the arbitration role, the public sector institutions need to understand how the industry functions within the legal and constitutional framework. An important role of governments in relation to industrial water use is to formulate polices and legislation that encourages industry to be efficient and transparent in their use of water. The success of these policies depends on their economic viability (both for the government itself and other stakeholders), ecological sustainability and social desirability for stakeholders, as shown in figure 9.1.

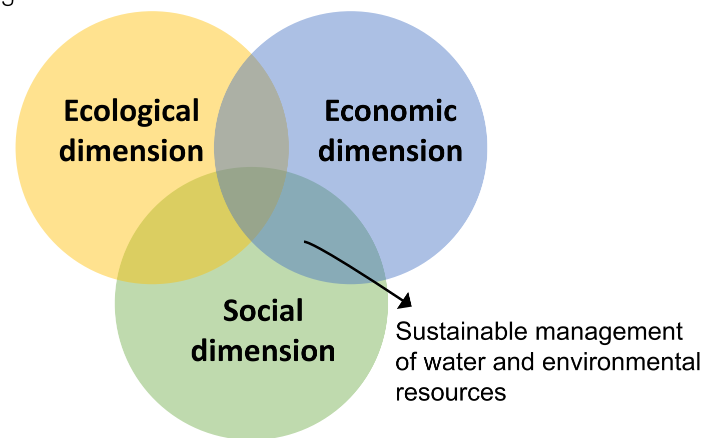


Figure 9.1. Triple-win situation for public-private partnerships

The role of governments may vary from country to country according to context, but the common points for all in relation to water management are as follows (Newborne and Mason, 2012):

- Policy formulation and development of regulations.
- Overseeing implementation of policies.
- Allocation of resources for water and sanitation and hygiene.
- Ensuring implementation of rules and regulations as regulator.
- Data collection and data management for decision-making (Figure 9.2).
- Based on the available data, support water users in access to water and sanitation services
- Arbitration for equitable distribution of resources.
- Commitment and fulfilling international obligations

9.2 Role of the private sector in water management

A literature review (Morrison and Gleick, 2002; Newborne and Mason, 2012; WFP, 2012; GoP, 2018c) reveals that the most important role of the private sector in water management is the development of innovative technologies (such as recycling) that reduce the volume of water and energy used in industrial operations. Industries can also enforce water use efficiency within their operations and in the operations of their suppliers through the value chains. Independently or in groups, industries have developed several instruments for water management and water use efficiency. An example is the 2030 Water Resource Group, a "public-private-expert-civil society platform" which includes multinational companies, aid agencies, an international conservation agency and partner governments in various countries. This group aims to play a role in water management at the basin scale, a role traditionally played by the public sector alone. The group supports public sector institutions by sharing information in catchments where data availability and reliability are a severe constraint for policy formulation and planning. The World Health Organisation highlighted issues in access to reliable data due to significant data gaps and fragmentation of available data across different ministries and stakeholders (WHO, 2017).

Various companies in developing countries have invested in the provision of drinking water and other services for the communities in which they operate. In summary, the role of the industry in relation to water management may be characterised as:

- Reducing water use in industrial operations.
- Wastewater treatment.
- Playing a role in increasing water efficiency in the operations of value chain partners (e.g. suppliers and growers)
- Assisting governments and other decision-makers in arbitration through investing in the collection of reliable data to be used in decision-making regarding water management.
- Financing water research.
- Investing in water infrastructure - corporate social responsibility towards neigh-

bours and affected people.

- Supplementing investments by the government in water infrastructure (both voluntarily and where it becomes obligatory).
- Policy advocacy for sustainable water resource management.

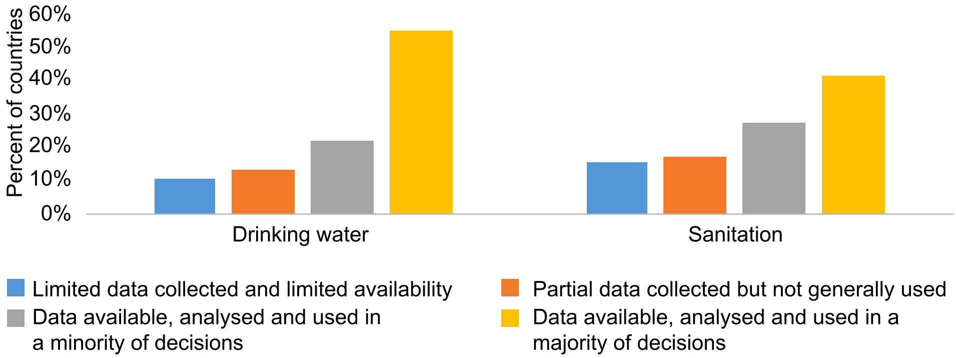


Figure 9.2. Extent to which countries collect data and use it to inform decisions (based on data for 65 countries). Source: GLASS 2017 quoted in WHO 2017

9.3 What do governments need to know to support the industry?

In the sections above, we have seen some of the main roles of the government and the industry. The government's role as described is rather general and applies to all water sector stakeholders. However, for a government to support a specific sector, it needs to know the sector itself: its size, water-related needs (quality and quantity), diversity, capacities and resources available to support water management in complementarity to the resources and capacities of the government. However, the starting point is government recognition of the industry as a partner - moving beyond the current perception of it being merely a user and polluter. Only then will the government feel the need to organise its information base on the sector in a manner conducive to forging partnerships. Ironically, this information base is generally sparse, especially in developing country governments. KP province provides a good illustration of these gaps.

The private sector in KP province

A major challenge is that full, reliable data on the size of the private sector in Pakistan, including KP province, is not available. The Khyber Pakhtunkhwa Industrial Policy 2016 (Government of KP, 2016b) indicates that the province has an extensive agriculture-based industry producing various products including tea, tobacco, match boxes, vegetable ghee and sugar. The policy reported a total of 12,000 industrial units out of which 2,299 are registered with the Directorate of Industries. Of them, approximately 1,821 small, medium, and large units are functional. Some commercial activities are regulated by the Industries Department whereas others, especially smaller activities such as mushrooming car-washing stations and cottage industries are neither listed nor strictly regulated. Fish farming, poultry farming, and commercial dairy are also important commercial activities for which the government has no reliable data. Data does not exist at all for other smaller commercial entities such as shopping centres, individual shops and hotels (Zia, Ali and Nizami, 2019). Available data for some categories is summarised in Figure 9.3.

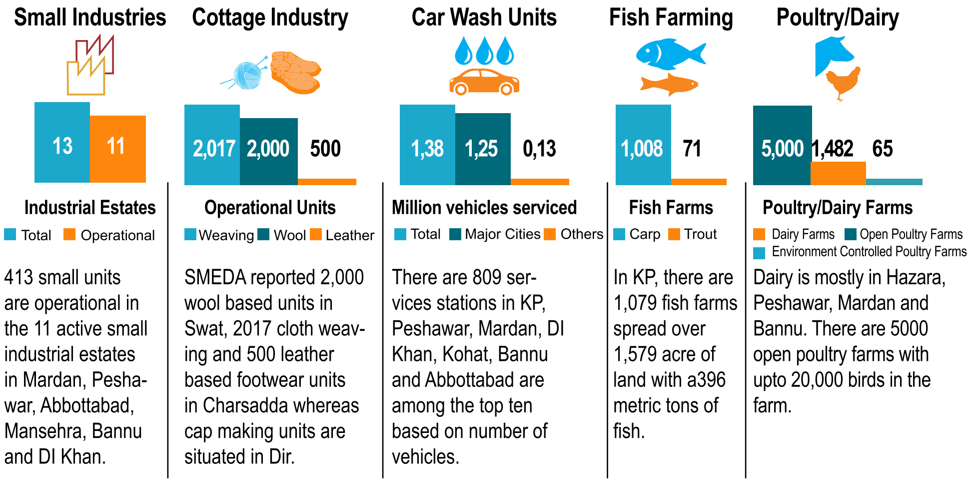


Figure 9.3. Summary of key water consuming industries, units and farms

Source of water for the industrial sector

The use of water by the private commercial sector is not well regulated in the country or in KP province; therefore, complete information cannot be derived from secondary sources. The National Water Sector Strategy, 2002 stated that industries make their own arrangements for water supply (GoP, 2002). By "their own arrangement", the policy seems to refer to the use of groundwater at their own cost. Apparently, this statement refers to large manufacturing units and does not include all other commercial entities (e.g., shops and small hotels situated within the cities and towns) which may use water provided by various government departments. Primary information collected for the IWRM sector paper on commercial use of water revealed that the sector uses all sources of water – piped, canal and groundwater. Nevertheless, groundwater is the main source of water feeding the major industries. Piped water or a combination of piped and ground water is used by some businesses situated within municipal areas.

Quantity of water used

Globally, around 20 percent of freshwater is used by industry (FAO, 2016). Although as indicated previously, there is no complete information for Pakistan, a few references indicate that the large manufacturing units in the country use 2.5% of the total available freshwater (UNDP, 2016); see figure 9.4.

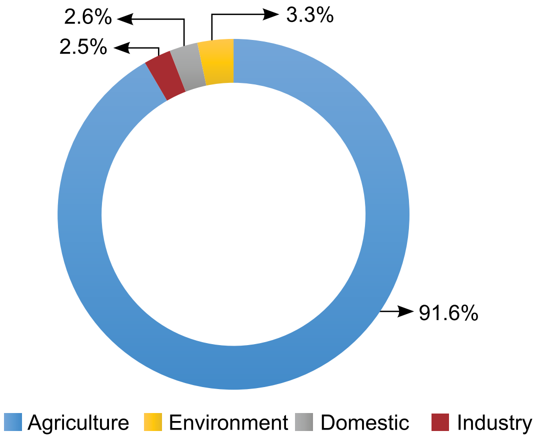


Figure 9.4. Percentage of water used by sub-sectors in 2016

Data available for certain industries suggests that significant quantities of freshwater are used. For example, the monthly water requirement of an industrial estate in Karachi was estimated to be 15 million gallons (MG Link, 2018). A car service station may need 16,000 litre water a day (Zahir et al., 2017). Approximately 3 to 4 litre of freshwater are required to produce one-litre soft drink (Haroon, Waseem, and Mahmood, 2012). This corresponds to the consumption of 20,000 – 30,000 m^3 water/year for a medium sized bottled drink company and 250,000 m^3 water/year for a large one. From the available secondary data, it is estimated that the daily freshwater use of six beverage factories (ibid) in the province could equate the daily domestic needs of 38,084 persons (based on 30 l per capita/day); seven cement factories (Sharma, Jain and Singhal, 2013) would use water equivalent to the daily needs of 966,737 persons. This not only underscores the significant needs of the industry for freshwater, but also highlights the increasing pressure on competing uses in the wake of water scarcity in the province.

Water contamination

Only 1% wastewater in Pakistan is reported to be treated by industries before being discharged into rivers and drains (Khan, 2015). About 3 billion litres of freshwater is annually converted into wastewater which could be used by 666,000 people for drinking purposes (Dawn, 2005; 2019). In general, industries do not have relevant environmental approvals. This is mainly due to the absence of monitoring of waste disposal into water bodies or the absence of facilities to treat wastewater in the industry and other commercial units. None of the beverage plants sampled all over the country by a committee constituted by the Supreme Court of Pakistan had flow meters. The overexploitation of groundwater is reported to have resulted in an increase in arsenic content in water. In KP province, 80,000 m^3 of industrial effluents containing high levels of pollutants are discharged daily (Khan, 2015). Pollutants released by the commercial sector include detergents, dyes, acids, sodas, salts, and heavy metals. Contaminated runoff from agricultural fields is also possibly leaching into the groundwater and residues are left in water flows and the air. There is no check on the quality and quantity of agro-chemicals applied in agriculture to acquire high and secure yields.

This situation did not emerge because the government lacks relevant policies. It is because the relevant National Environment Quality Standards approved by the government are not properly enforced. A weak enforcement of laws is due to weak monitoring systems, low capacity of enforcement agents and unethical practices by the industries for short term benefits.

Water tariffs

As stated earlier, water use by all actors has long been poorly regulated in Pakistan, including KP province. Water is considered a free good provided by the state. Where possible, the private sector, especially commercial units situated in urban centres, have used subsidised drinking water supplied by various government departments and intended for domestic uses. This is yet another example of weak monitoring on how water supplied by the state is being used.

Free water, however, will soon be a thing of the past due to scarcity and competing uses. Pressure is increasing on water management authorities internationally and in Pakistan specifically to improve the financial sustainability of water resources. As a result, the licenses of private companies to use groundwater have been revoked in some countries and the role of the private commercial sector in the depletion and contamination of water resources is being criticized in many countries including Pakistan. For example, in 2018 the Supreme Court of Pakistan asked the authorities and industries selling bottled water to develop sustainable water use mechanisms including an additional cost for selling water for commercial purposes. Even before the instruction of the Supreme Court, KP province had revised water tariffs for piped drinking water both for domestic and commercial uses (with higher tariffs for the commercial sector compared to the domestic sector). However various government agencies charge different tariffs in the same city. For example, a government agency supplying piped drinking water in parts of the capital city charges Pakistan Rupees (PKR) 424 for domestic uses compared to PKR 4,830 for service stations and small hotels, whereas another government agency charges PKR 532 for domestic uses compared to PKR 5,844 for petrol and car-washing stations. In another city, piped water is provided free for domestic uses and is also availed free of cost by some private entities. However, most private entities, especially large industries, have their own arrangements for water supply - mainly groundwater. In such cases, the private commercial sector does not recognise that the water still belongs to the state and should be paid for and judiciously used.

The current water tariffs are flat, on a connection basis rather than the volume of water used. Current discussions related to tariffs for industry focus on increasing the tariffs for a connection rather than on introducing a volumetric payment system. Given the low costs, industries will be happy to pay a flat tariff for a water connection. However, in the long run, the introduction of a volumetric system will be more transparent and will benefit both the government and the industry. This may serve an important topic for a public-private partnership dialogue that allows both partners to recognise the benefit of a transparent volumetric billing. As an example, water tariffs being charged by the WSSP in 2019 are given in Table 9.1.

Table 9.1. Revenue tariffs for water and sanitation services by WSSP

Category	Connection charges 1/2 inches dia PKR.	Total monthly charges piped water PKR.	Groundwater connection fee PKR.	Groundwater monthly fee PKR.
Residential (10 marla)	8,200	460	50,000	350
Factories	Not listed	Not listed	Not listed	Not listed
Restaurants	13,800	2,225	Not listed	Not listed
Service Station	41,400	4,830	100,000	5,000
Shops	11,040	1,470	Not listed	Not listed
Plaza (upto 50 shops)	20,000	6,125	200,000	5,000
Plaza (51-100 shops)	30,000	9,100	500,000	7,500
Plaza (101- & above shops)	40.000	15,050	1,000,000	15,000
Hotel 5 star	Not listed	Not listed	1,000,000	15,000
Hotel 0 star	15,000	15,000	200,000	5,000

Polluters pay principle

Discussions on water management in Pakistan so far have focused on the quantities of water used and tariffs. The implementation of the 'polluter pays' principle has not yet been widely raised. There is no dearth of policies and legal provisions for pollution control, specifically on water pollution. However, on the ground very little has been achieved to make polluters pay – the responsible controlling institutions having failed to implement the regulations. One measure for controlling water pollution could have been to introduce high tariffs for releasing untreated contaminated water into the environment. Such a tariff could have been first introduced in a cohesive manner to the private sector entities that convert huge quantities of freshwater into wastewater. The introduction of such a system needs reliable data on the size of the private sector in the province and on the volume of water used and being contaminated by specific private entities. A proper monitoring at the end-user level would also be necessary. Given the lack of such data, polluters get away without paying. Figure 9.5 provides a few examples of the industrial use of water with the source, volume of water used per production unit, volume of contaminated water per production unit and contamination being released.

Industry	Water In	Source: GROUND	Source: SURFACE	Source: CANAL	Waste Out	Above limits: BOD	COD	TDS	TSS	PH	
Beverage	3-4 ltr/ltr	■	□	□	-	■	□	□	□	□	Starch, Citric acid and Sugar
Paper	75 m³/ton	■	□	□	70 m³/ton	□	□	□	□	□	Deteriorating aquatic life and availability of drinking water
Marble	-	■	□	□	182 m³/day	■	■	□	□	□	-
Match	-	■	□	□	227 m³/day	■	■	■	■	□	Heavy metals (Pb and Cr) in the effuents above permissible limit
Steel	28.6 m³/ton	■	□	□	25 m³/ton	■	■	□	■	□	Heavy metals
Pharma	-	■	□	□	108 m³/day	□	□	□	□	□	Amonia, Acids, Zinc
Sugar	1.6 m³/ton	■	□	□	0.4 m³/ton	■	■	■	□	□	Acidic and Alkaline compounds. High concentration of sugar
Textile	169 m³/ton	■	□	■	143 m³/ton	□	□	□	□	□	PBDEs, phthalates, organo-chlorines, lead and other chemicals
Soap	-	■	□	□	-	■	□	■	□	□	Chemical oxygen demand, anions, cations, surfactants
Fish	42 ltr/fish	■	■	□	-	□	□	□	□	□	-
Ghee/oil	-				155 m³/day	■	■	□	□	□	Highly turbid and milky in color with bitter smell
Cement	0.92 m³/ton					□	□	■	□	■	-
Fertilizer	-	■	□	□	-	□	□	■	□	□	Organics, alcohols, ammonia, nitrates, phosphorous, cadmium
Leather	192 m³/ton	■	□	□	-	□	□	□	□	□	3.5 - 6.5% solids, 20-48% volatiles and 51-74% inorganic matter
Brick Kiln	0.53 m³/ton	■	□	■	~100 m³/ton	□	□	□	□	□	-

Figure 9.5. Industrial water usage, wastewater produced, and contamination. Source: Dawn, 2005; 2019; Haroon, Waseem and Mahmood, 2012; Sharma Jain and Singhal, 2013; Khan, 2015; Zahir et al., 2017 and MG Link, 2018

9.4 Legislation on water use and pollution

Various policy and regulatory documents have sections which directly and indirectly pertain to controlling water pollution by the private sector. However, specific controlling mechanisms on water use by the private sector are generally missing. For example, section 15.2 of the National Water Policy, 2018 states that the 'industry shall be required to carry out in-house treatment of their wastewater before transfer to municipal sewer as per National Environmental Quality Standards and the "Polluter Pays" principle shall be strictly enforced" (GoP, 2018c). The Khyber Pakhtunkhwa Drinking Water Policy, 2015 identifies duplication and overlapping roles of water sector stakeholders resulting in the uncoordinated and inefficient use of resources (GoPK, 2015b). The policy also states that there is no direct accountability or link between cost recovery and service provision in drinking water.

The National Water Policy, 2018 emphasises the regulation of groundwater withdrawals for curbing over-abstraction and pollution. The policy suggests 100% metering for financial sustainability and the enforcement of legislation for controlling water pollution by industrial units and municipal entities. Nevertheless, water pollution remains uncontrolled. The existing regulations on environmental protection provide enormous powers to the authorities to control pollution and apply to all, including the private sector. For example, the Khyber Pakhtunkhwa Environmental Protection Act, 2014 provides extensive power to the provincial Environmental Protection Agency to control pollution including water pollution by users.

These issues are now being recognised. An example is the introduction of separate tariffs developed by the government for some of the cities of KP province. However, as emphasised by the National Water Policy, 2018, a more effective means of managing water use efficiency will be pricing on the volume of water used, since increasing tariffs on a flat rate basis does not guarantee the efficient use of water. Volumetric tariffs coupled with subsidised rates for industries that introduce improved water efficient technologies and treat their wastewater may incentivise industries to adopt water efficient production systems. This may also be an incentive to reduce pollution. Peshawar city has only one modern car service station that minimises water use in car washing, limits its use of chemicals, and releases wastewater after some treatment. Such initiatives need to be encouraged by subsidising water tariffs for a specified period so that others also feel the urge to convert to water efficient technologies. Any legislation to force conversion to an appropriate technology based on environmental arguments is likely to fail in implementation; there are many such examples in the country. A wiser and more rewarding pathway would be to find a win-win system of investment and incentive for the industry and business.

9.5 Challenges in regulating resource use by the industrial sector

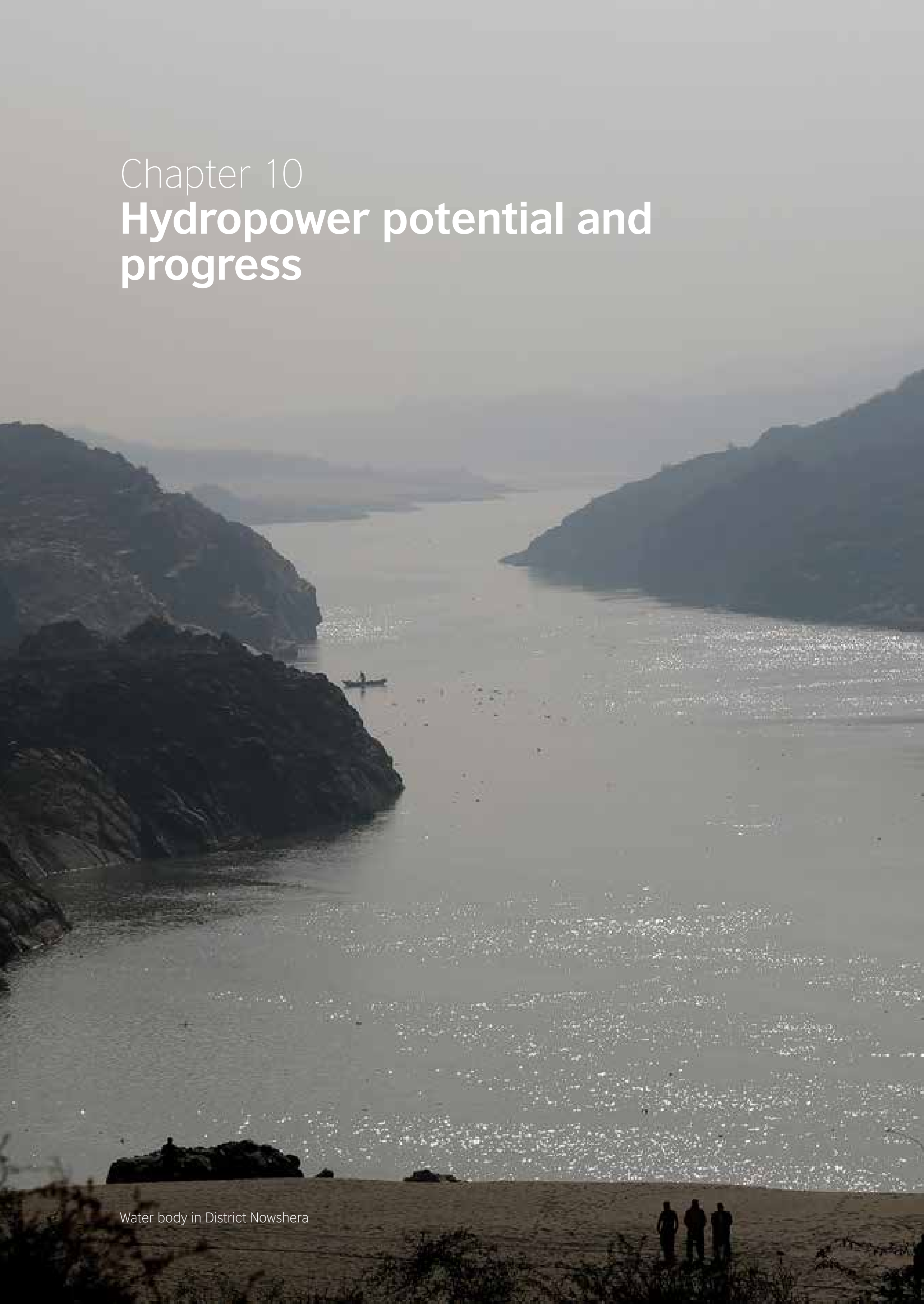
To conclude this chapter, the range of challenges in regulating industrial water use in KP province, and indeed more widely, include the following:

- Ambiguities in the roles and responsibilities of various water management authorities.
- Inefficiencies in collection of revenues due to political influences.

- Lack of information on the size of commercial sector.
- Lack of information on the needs and demand for water by the private commercial sector.
- Lack of information on the use of water by the private sector (piped water supplied by the authorities, groundwater, and canal water).

Some of the measures now being taken that go in the right direction include strong enforcement of available laws in collaboration with the private commercial sector, regulating water use by the private sector, investing into user friendly technology for improving water use efficiency and safe water disposal, and encouraging public private partnership initiatives. Even more urgent is to improve the data on private sector water use and to change the prevailing view and attitude of the public sector towards the private sector from that of a polluter to a contributor and investor in the water sector. Making the private sector part of the solution to water issues is urgently needed.

Chapter 10
Hydropower potential and progress



Water body in District Nowshera

Chapter 10
Hydropower potential and progress

Muhammad Naeem Khan
Munawar Khan Khattak

Hydropower development in Pakistan started in 1925 with construction of 1.1 MW Renala Khurd hydropower station in Punjab province. At the time of independence, Pakistan inherited a very small power base of only 60 MW capacity for its 31.5 million population. By the creation of WAPDA in 1958, the country's total hydropower had reached 119 MW. On signing the Indus Water Treaty in 1960, Pakistan became entitled to use 145 MAF of surface water. Subsequently, the 240 MW Warsak, 1,000 MW Mangla and 3,478 MW Tarbela dam projects were constructed, taking the power status of the country to a reasonable level.

10.1 Current power generation in Pakistan.

The current power generation in the country is about 25,000 Megawatts (MW). Of this, around 67% is thermal power (furnace oil and indigenous gas), the breakdown being 31% managed by generation companies (GENCOs) and 36% managed by independent power producers (IPPs). Almost all the balance, around 29%, is hydropower managed by the Water and Power Development Authority (WAPDA) and IPPs; of the remainder, 3% is nuclear and 1% is wind power. The details are presented in Table 10.1 whilst the ratio of various types of power generation is provided in Figure 10.1.

Table 10.1. Existing installed power generation capacity in Pakistan (2018)

Type of generation	Installed capacity (MW)	Energy generation (GWh)
Hydropower by WAPDA	6,902	31,525
Hydropower by IPPs	213	1,038
Thermal GENCOs	7,633	22,621
Thermal by IPPs	9,085	53,139
Nuclear	787	5,349
Wind	256	621
Total	24,876	114,293
Source: KP Energy and Power Department, Government of KP		

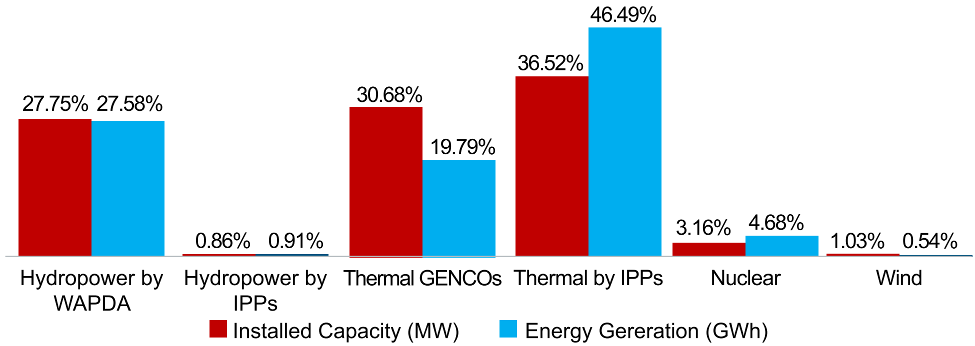


Figure 10.1. Ratio of existing installed power generation capacity in Pakistan (2018)

Electricity is needed for the socio-economic development of the country. However today only about 70% of the country's population has access to electricity. The present gap between power demand and supply can reach over 5,000 MW at critical times. High power tariffs and load shedding are important factors in low economic growth and the decline of industrialisation in the country. The historic demand and future forecast at an average growth rate of 8% indicate that the electricity requirement will rise to more than 62,000 MW in the year 2030 (GoP, 2014). This necessitates proper, timely planning in the energy sector.

Even based on an assumed conservative annual compound growth rate of 7.5%, it is projected that Pakistan's peak electricity demand will increase from 29,000 in year 2016 to 76,000 MW in year 2030. The projected yearly growth pattern is provided in Figure 10.2. The graph shows that the annual power needs are increasing rapidly (by 159% from 2016 to 2030) whereas progress on power projects fails to match the rise in demand (GoP, 2013).

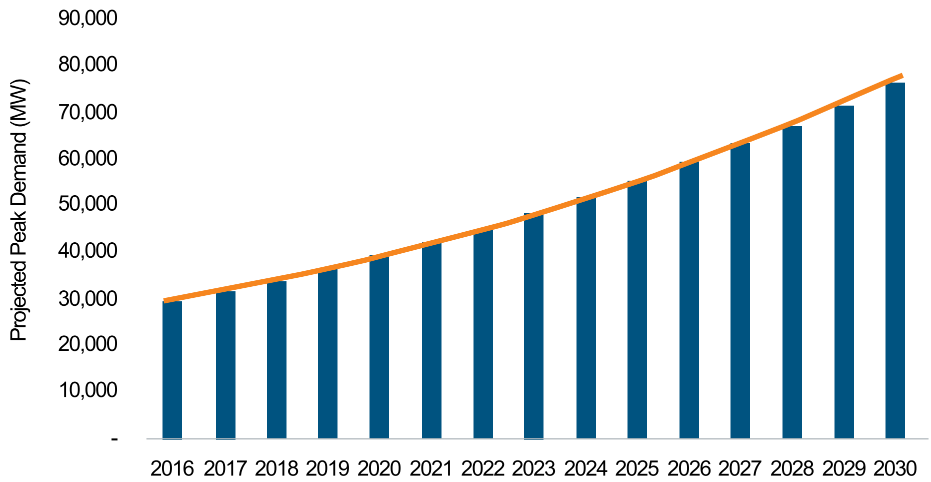


Figure 10.2. Projected peak electricity demand (2016 -2030) of Pakistan

The National Power Policy, 2013 (GoP, 2013) set out the following priorities to cope with the medium-term electricity demand:

1. Adding coal-based thermal generation on account of their short-term gestation period and low running cost as compared to oil-based stations.
2. Bringing the old de-rated thermal plants of WAPDA (operating at lowered capacity to prolong life) to design capacity including a switch-over to coal from other fossil fuels.
3. Preferring run-of-river hydropower facilities with a somewhat shorter gestation period as compared to multi-purpose storage projects.
4. Adding 10,400 MW generation under the China-Pakistan Economic Corridor, CPEC, in the shortest possible time. However, this only includes 1,590 MW of hydropower at Suki Kinari on Kunhar (720 MW) and Karot on Jhelum (870 MW).
5. Tapping un-conventional power sources of solar, wind and biomass through the private sector.

The above stated strategy reveals that the multipurpose development of surface water has been totally ignored, despite it being not only essential for cheap energy production but also for the much-needed storage of water for agriculture and other uses. Hydropower also provides an opportunity to develop climate-friendly energy that does not contribute to carbon emissions. One important way in which this can be achieved through the priority development of Diamer Basha Dam Project (DBDP) in conjunction with downstream cascade projects in the Indus River reach up to Tarbela. The government is now investing in the construction of the DBDP and phase-one of the Dasu Power Project, and it is anticipated that the construction of the second phase of the Dasu project will also be prioritised. Investment under the CPEC project provides an opportunity to speed up work on these projects.

10.2 Hydropower potential in Pakistan

Pakistan's hydropower resources are mainly located in the mountainous areas of the North of the country, notably in Khyber-Pakhtunkhwa (KP), Gilgit-Baltistan (GB) and Azad Jammu and Kashmir (AJK) (Figure 10.3). The hydropower resources in the South, being scarce, mainly comprise small to medium schemes on barrages and canal falls. The Indus River System (IRS) is a real blessing for Pakistan, comprising the Indus, Jhelum, Chenab, Ravi, Bias, and Sutlej rivers along with its northern tributaries of the Chitral, Swat, Panjkora, Kabul, Harrow, and Soan. The average annual inflows are 170 billion m^3 out of which about 22 billion m^3 of live storage has been harnessed, representing hardly 14% of the total available inflow.

Pakistan is blessed with a huge total potential of 100,000 MW hydropower; its identified potential is close to 60,000 MW (WAPDA, 2011). Out of the total potential, so far less than 7% has been exploited[45]. The current installed capacity of the country is about 7,000 MW. In terms of the total electricity generation in the country, the share of hydropower is about one third. New reservoirs are urgently needed to reverse the present hydel-thermal share from 1:2 to 2:1 in order to meet the demand for cheap electricity which is essential for the sustainable economic growth of Pakistan. From the viewpoint of climate change, hydroelec-

45 Report on 74th Annual Symposium of Pakistan Engineering Congress, 2017.

tricity has lowest carbon footprint compared to thermally produced power using fossil fuels.

Data in Figure 10.3 indicates the location of the hydropower potential identified for future development. The largest potential for 24,736 MW lies in KP followed by Gilgit-Baltistan 21,725 MW, Azad Jammu & Kashmir 6,450 MW and Punjab 7,291 MW (PPIB, 2011). About 89% of this hydropower potential is still untapped.

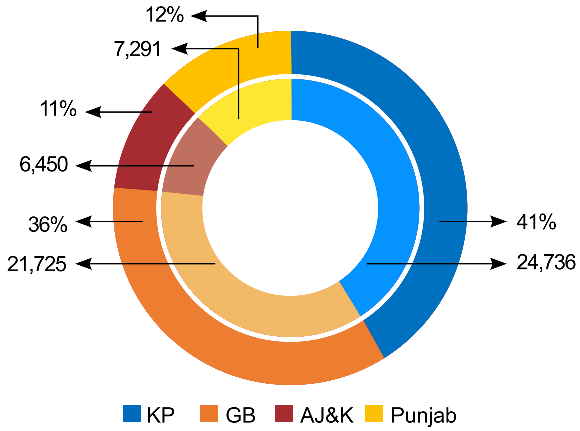


Figure 10.3. Hydropower potential of Pakistan (MW)

Figure 10.4 shows the distribution of the total installed capacity in various administrative units of the country, in descending order as follows:

- KP 4129 MW
- Punjab 1699 MW
- AJK 1039 MW
- Gilgit-Baltistan 133 MW.

Hence KP has the highest installed capacity (59%) in the country (Government of KP, 2016c).

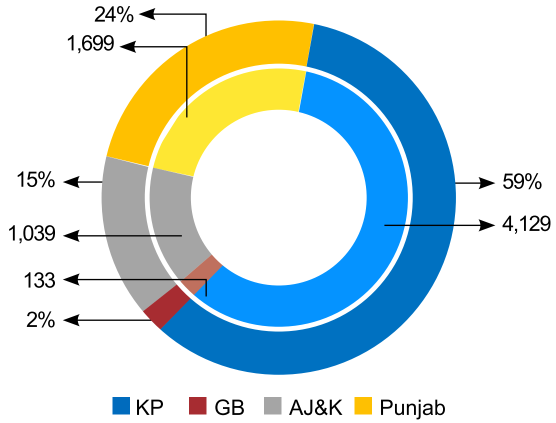


Figure 10.4. Region-wise installed capacity of hydropower projects in Pakistan (MW)

10.3 Hydropower potential in KP

Several years after the construction of the mega hydropower projects of Tarbela and Warsak the Government of KP established Small Hydel Development Organization (SHYDO) in 1986 for the following basic purposes:

- Identify and develop hydel potential up to 5 MW.
- Construct small hydel stations for isolated load centres.
- Operate and maintain off-grid small hydel stations.

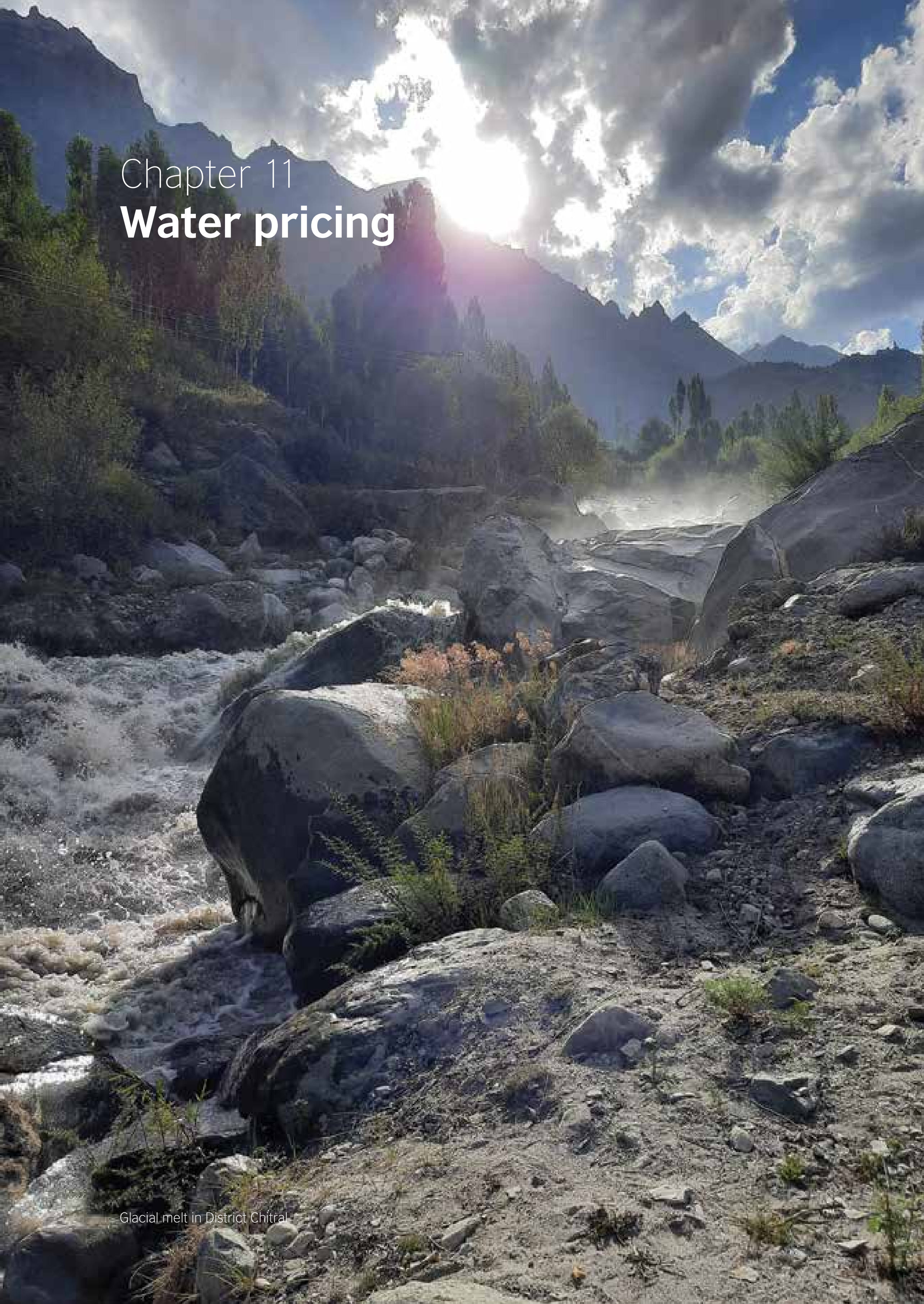
SHYDO was under the administrative control of the Irrigation and Power Department. In 1993 SHYDO was converted into an autonomous body under the Pakhtunkhwa Energy Development Organisation Act 1993 (Government of KP, 1993) and was renamed the Sarhad Hydel Development Organisation. In 2013 the name of the organisation was once again changed to the Pakhtunkhwa Hydel Development Organisation (PHYDO) due to change in the name of the province from NWFP to Khyber Pakhtunkhwa. In 2014 a new Department was established with the name of Energy and Power and PHYDO was converted into the Pakhtunkhwa Energy Development Organisation (PEDO) through an amendment in the Pakhtunkhwa Energy Development Organisation Act 1993 and the PEDO (Amendment) Act 2014 (Government of KP, 2014). PEDO is an autonomous body of the government of KP and is responsible for the fast-track development of the province's energy sector. PEDO is working to explore all possible energy avenues including hydro, solar and wind energy. As KP has immense potential for the development of hydropower, this form of power generation is being given priority, and private sector investment is being encouraged. Thermal power generation based on natural gas or coal also comes within the purview of PEDO (ibid).

Mega projects located within KP are implemented and managed by the federal government (WAPDA). At the time of writing, the operational projects have a capacity of 9,462 MW while projects under construction have 3,171 MW capacity. Projects ready for construction have potentially 18,521 MW capacity. There are many more projects under study. PEDO mostly develops medium scale hydropower projects designed on the run-of-river, with some having a small ponding for peaking. Therefore, the local hydropower projects have no major impact on the water use and environment of the province.

The weak and deficient transmission and distribution system in KP is one of the root causes of load shedding. Due to this, the distribution company (PESCO) cannot consume its due share of 13.55% of the total national generation. One way to improve this situation would be for the federal government to support PESCO to improve its transmission and distribution system.

Chapter 11

Water pricing



Glacial melt in District Chitral

Chapter 11
Water pricing

Jawad Ali
Arjumand Nizami

This chapter provides an overview of water pricing systems in Pakistan with special reference to drinking water in KP province. The purpose is to introduce the topic and issues related to it, without providing an exhaustive literature review.

There are two milestone global policy positions on access to drinking water.

The Dublin Statement[46] on Water and Sustainable Development in 1992, also known as the Dublin Principles, emerged from the International Conference on Water and the Environment (ICWE), Dublin, Ireland. The Dublin Statement recognised the scarcity and misuse of fresh water as a serious and growing threat to sustainable development and the protection of the environment. Without sustainable water and land management, human health and welfare, food security, industrial development, and ecosystems continue to be at risk since every ingredient of life depends on water. The Dublin principles resolved that concerted action is needed to reverse the present trends of overconsumption, pollution, and rising threats from drought and floods. The four principles agreed in Dublin are briefly explained below.

Principle 1: Freshwater is a finite and vulnerable resource, essential to sustain life, development, and the environment. Since water sustains life, the effective management of water resources demands a holistic approach, linking social and economic development with the protection of natural ecosystems. Effective management links land and water uses across the whole of a catchment area or groundwater aquifer.

Principle 2: Water development and management should be based on a participatory approach, involving users, planners and policymakers at all levels. A participatory approach involves raising awareness of the importance of water among policymakers and the general public. It means that decisions are taken at the lowest appropriate level, with full public consultation and the involvement of users in the planning and implementation of water projects.

Principle 3: Women play a central part in the provision, management and safeguarding of water. This pivotal role of women as providers and users of water and guardians of the living environment has seldom been reflected in institutional arrangements for the development and management of water resources.

Principle 4: Water has an economic value in all its competing uses and should be recognised as an economic good. It is vital to recognise first the basic right of all human beings to have access to clean water and sanitation at an affordable price. Past failure

46 http://www.tvrl.lth.se/fileadmin/tvrl/files/vvrf01/The_Dublin_Statement.pdf

to recognise the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way to achieve efficient and equitable use, and to encourage conservation and the protection of water resources.

The emphasis of the Dublin Statement on the economic value of water rather than water as a universal right was highly contested by human rights activists (although the full text of principle 4 does state it is vital to recognise first the basic right of all human beings to have access to clean water and sanitation at an affordable price). Voices in favour of sustainable development however strongly adhere to this position since this is the only way to secure future of water.

In November 2002, the UN Committee on Economic, Social and Cultural Rights adopted General Comment No. 15, which was formulated by experts as a counter narrative. This comment takes a hybrid position by recognising water as a limited natural resource, a public good and a human right. This step - adopting General Comment No. 15 - was a decisive step towards the recognition of water as universal right.

The human right to safe drinking water was first formally recognised by the UN General Assembly and the Human Rights Council as part of binding international law in 2010[47]. The UN resolution stated, "the right to safe and clean drinking water and sanitation as a human right that is essential for the full enjoyment of life and all human rights"[48]. "People are rights-holders and States are duty-bearers of providing water and sanitation services. Rights-holders can claim their rights and duty-bearers must guarantee the rights to water and sanitation equally and without discrimination. The 'human rights-based approach' stresses the correspondence between rights and obligations......[49]. SDG 6 focusses on water and sanitation delivery for all. When the SDGs were adopted in 2015, one in three people in the world had no access to safe drinking water. Recognising the growing challenge of water scarcity, the UN General Assembly launched the Water Action Decade in 2018, to mobilise action towards transforming how water resources are managed.

Since water is necessary for the survival of human beings and all other living things, any discussion on water pricing and its commoditisation becomes very sensitive. Despite high subsidies and spending by the governments, the idea of providing safe and free drinking water for all has not worked well (Segerfeldt, 2005). In 2019, around 785 million people globally (mostly in the developing world) lacked access to safe water and 2 billion people lacked access to a toilet[50]. In Pakistan 21 million people did not have access to clean water close to home[51].

As opposed to providing highly subsidised drinking water – a strategy that has so far not proved very efficient in many countries - the privatisation of water and sanitation services

47 https://www.unwater.org/water-facts/human-rights/
48 https://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/64/292
49 https://www.unwater.org/water-facts/human-rights/
50 https://water.org/our-impact/water-crisis/
51 https://www.wateraid.org/pk/facts-and-statistics

is considered an alternative option to improve services. Through privatisation, it is believed that market forces will come to play so that supply can meet demand (Segerfeldt, 2005). Since the private sector aims at customer satisfaction, it is expected that the customers will get clean water. An alternative to complete privatisation of water and sanitation services is community/user participation and management of drinking water schemes. It is believed that better services and water quality will automatically justify tariffs especially if the money collected is being used for the community and by the community itself for the better maintenance of water services. Priced water will also be used more cautiously, eventually reducing wastage. In any case, especially if the provision of drinking water is privatised, disadvantaged groups will need government support to ensure they are not deprived of the required quantities of quality drinking water because they are unable to pay for such services.

11.1 The challenge of water pricing

Objective analysis is needed regarding the inability of public services to serve a fast-growing population with an adequate quality and quantity of water with a limited revenue generation. Drinking water is considered a welfare good and the public services are expected to provide water at the doorstep of the right-holders. Currently, drinking water charges are levied on a flat rate system (per connection), which does not help in assuring resource use efficiency. As described in the case of industries (Chapter 9), water is nearly a free commodity and is treated as an infinite good in all spheres. Changing to volumetric pricing (through water metering or other measuring means) or pricing by the type of use is highly political and complex in Pakistan. An appropriate water pricing and proper system of revenue collection could check the misuse of water.

The core challenge in water pricing has been lack of clear policy position in Pakistan. As a first historical policy step in this direction, The National Water Policy 2018 calls for a realistic water pricing policy, including affordable rates for rural water supply and sanitation services. The Policy urges provinces to establish and implement an effective water pricing policy. The policy further states: "Water is a highly under-priced commodity in Pakistan. The prevailing cost recovery through water charges (water tax or *Abiana*, in the case of agriculture) meets only a fraction of the operation and maintenance (O&M) cost of the irrigation infrastructure. Measures are required to enhance the water charges to realistic extent to meet the O&M cost of the infrastructure and to ensure long-term sustainability. Water Charges for industrial uses will also be rationalised. Within these broad parameters of water security, the provincial governments can formulate more detailed policies and guidelines on other subjects like water pricing".

In another place, the National Water Policy states, "Water is a strategic resource and access to affordable and safe drinking water is a fundamental human right of all citizens" (clause 3.7.2). In principle, this puts a stop to any controversy or tension between water being a human right or an economic good. It is a fact that the sole position from a human right perspective did not take us anywhere despite huge investment of public resources and donors' assistance. Pakistan is 9th on the list of 10 countries with the lowest access to potable water in 2018[52], although the situation has reportedly improved during the last ten years. The National Water Policy recognised both sides, suggesting to the provinces that a combination of the two approaches needs to be pursued. The poor spend huge amounts of productive time, human and financial resources in acquiring domestic water and that too of inadequate quantity and quality. What is the benefit of a free good when it is not available to the right-holders and they are obliged to spend their own precious means (time, labour, money) to procure water to meet their limited needs? This effort, using up a significant proportion of their meagre resources, renders domestic water practically unaffordable for the poor.

11.2 Current regime of water tariffs - domestic and commercial

Water for drinking and domestic purposes is supplied by various organisations. The Tehsil Municipal Committees (TMAs) are responsible for urban area while the Public Health and Engineering Departments (PHEDs) are responsible for the rural areas. Various city development authorities also supply water in parts of cities. Private societies mostly have their own water supply arrangements banking on groundwater, which is supposedly a state property.

As stated above, the current tariff system for water and sanitation in Pakistan is based on monthly flat rate. Bills are issued either according to property size or type of use (domestic or commercial). Tariffs for water and sanitation are highly subsidised; in some areas, water is supplied free. For example, in some areas of KP province, no fee is charged for piped water since 2015 when the fee was waved off through a resolution in the KP provincial assembly. In other parts of the province, nominal fees are charged. As an example, in one town in KP, the TMA charges (monthly) PKR 150 for domestic uses, PKR 1,000 for service stations and class A hotels, PKR 800 for class B hotels and bakeries, and PKR 200 for all other shops. Water tariffs in the rest of the country are also highly subsidised. Flat bills vary from PKR 72 to PKR 800 with only 25%-40% collection efficiency (Bilal, 2016).

Although water fees for the commercial sector are higher than for the domestic sector, they are low when compared to the cost of pumping and managing groundwater. Therefore, where available, the commercial sector prefers piped water supplied by TMAs, PHEDs and others public sector organisations. An additional benefit for using water supplied by the public sector is evading tariff payments – a tactic typical in the country for all types of services provided by the government (e.g. gas and electricity). However, large commercial units need greater quantities of water than can be supplied by public sector organisations. Furthermore, such units are generally situated outside settlements. Therefore, they make their own arrangements, sourcing groundwater which they obtain free of cost.

52 http://www.technologyreview.pk/the-perils-of-drinking-water/
The ten countries with the lowest access to drinking water close to home are India, Ethiopia, Nigeria, China, Democratic Republic of Congo, Indonesia, Tanzania, Uganda, Pakistan, and Kenya. https://washmatters.wateraid.org/sites/g/files/jkxoof256/files/The%20Water%20Gap%20State%20of%20Water%20report%20lr%20pages.pdf

The Water and Sanitation Services Peshawar (WSSP) has also introduced licenses (one-time connection fee) and monthly fees for pumping groundwater. For example, the connection fee for a car service station is PKR 100,000 and for a 5-star hotel it is PKR 200,000. This system is new and has not yet been introduced in most parts of the city or in other parts of the province by the respective WSSs and other relevant institutions.

11.3 Efforts to improve water and sanitation services and revenue collection

The government has established autonomous bodies to improve drinking water services in some areas of the country. The establishment of Water and Sanitation Service companies (WSSs) in eight major cities of KP, Water and Sanitation Agencies (WASAs) in Punjab, and the Punjab *Saf Pani* project are examples. Implementation of these efforts however faces challenges due to political factors, incomplete information related to demand to plan supply, and absence of governance structures to ensure quality service provision with efficient revenue collection from users.

The WSS companies in KP were established in 2014. "WSSP was established as Pakistan's 1st corporate governed, professionally managed, autonomous yet accountable to Board of Directors (BoD) and ring- fenced utility to provide world class services of water, sanitation, and solid waste to citizens of urban Peshawar"[53]. Key challenges faced by WSS companies include revenue collection and generation, communication with users, interruptions of electricity, aging water supply systems and limited finances (Cooper, 2018). The WSS Peshawar is currently receiving subsidies from the government but aims to be financially autonomous. It is planning to fix water meters for individual housing units and to build its ability to collect volumetric tariffs. Fixing water meters will encourage water conservation and may allow government subsidies to go to the poor through progressive pricing by use brackets, as in case of electricity or gas. The WSS Peshawar has introduced new flat rate tariffs and has increased fees, both for the domestic and commercial sectors. Connection and monthly fees for the commercial sector are quite high compared to those for domestic uses. For example, connection charges for domestic uses for piped water are PKR 8,200 compared to PKR 11,040 for shops and PKR 41,400 for service stations. Monthly charges for domestic uses are PKR 460 compared to PKR 4,830 for service stations and PKR 1,470 for shops. Before the introduction of new tariffs, monthly fees were as low as PKR 150. Discussion with WSS Peshawar staff reveals that fee collection rate is not very satisfactory.

The use of meters may be extremely helpful in inducing efficiency in water use and the effective collection of revenue. This efficiency is a key to ensuring access of water by more users, especially those at the tail end of any pipeline where water often fails to reach as upstream users misuse water without fearing financial penalties. However, so far efforts have not been successful due to limited capacity and ownership of the issue. The discussion with senior officers within the service institutions suggests that the core

53 https://wssp.gkp.pk/en_US/kp-wsscs-chapter/

argument against metered supply of water is that poor households would be unable to pay and feel yet another burden on their shoulders after paying for electricity and gas. However, the examples quoted below from Punjab and many other cases in Chitral and Gilgit-Baltistan where communities manage drinking and irrigation water infrastructure do not support these arguments.

In a pilot project in Rawalpindi, most of the 5,000 water meters installed were reported to have been made intentionally dysfunctional within a short time period (Bilal, 2016). Water charges in this pilot project were only PKR 35 per unit (1 unit is approximately 1,000 litre). On the other hand, it is reported that the *Changa Pani* scheme being piloted in parts of Bhalwal, Sargodha, Lahore and Faisalabad is functioning well (ibid). In this scheme, the community participated in the construction of the water supply schemes, shared the construction cost, and pays monthly volumetric tariffs. *Changa pani* reports that the overall volume of water required by households reduced after the installation of meters and thus more users could be brought into the scheme. Other successful examples are community managed drinking water supply schemes in Chitral and Gilgit-Baltistan. This is a different kind of pricing regime since funds thus collected are used for O&M by the user community. In the case of government schemes, the government pays for this service and hence water is totally for free or highly subsidised to the user. If the community manages a water scheme, the community members also pay the full price for the service. The result is an inbuilt sense of obligation for duty bearing since those who do not get good service will refuse to pay. The red thread running through these few successful examples, and the clear lesson to be learned, is that users need to participate in the planning and management of drinking water supply systems.

11.4 Pricing of irrigation water

There exists a well-documented revenue assessment and collection system in the Irrigation department in all provinces under which irrigated land is assessed and charged based on acreage (Sial and Nizami, 2018; Khan 2007; Waqar, Jehangir, Mudasser and Hussain, 1999). Following an assessment of the crop area and its verification by the controlling officers of the revenue department, the abstract of water charges against the name of the consumer is sent to the concerned officials at the District Commissioner's office where the water charges are collected through *Lumberdars*[54]. To improve the water charge collection system, in 2004 the provincial government of KP shifted responsibility to the Irrigation department with an incentive that 5% of the fee collected would be given to the revenue staff. Even this system did not give the desired results as all the operations are manual and not digitised.

Khan, 2007 noted that despite massive investment, water scarcity and the inefficient use of water remain major constraints in the agriculture sector. Important reasons for the poor maintenance of infrastructure and irrigation inefficiency include non-realisation of the value of water by the agriculture sector, wastage of water in the irrigation system, and low *Abiana* recoveries. The irrigation system is not properly maintained due to the

54 A village headman or registered representative of a village paid by the revenue department

paucity of funds and water is not judiciously used because of its negligible cost. *Abiana* is recovered based on a system of varying water charges according to the crop type. It does not reflect the relative consumption requirements nor take into consideration the inequitable water supplies in various reaches of the system. Neither does it reflect the cost of maintaining the system.

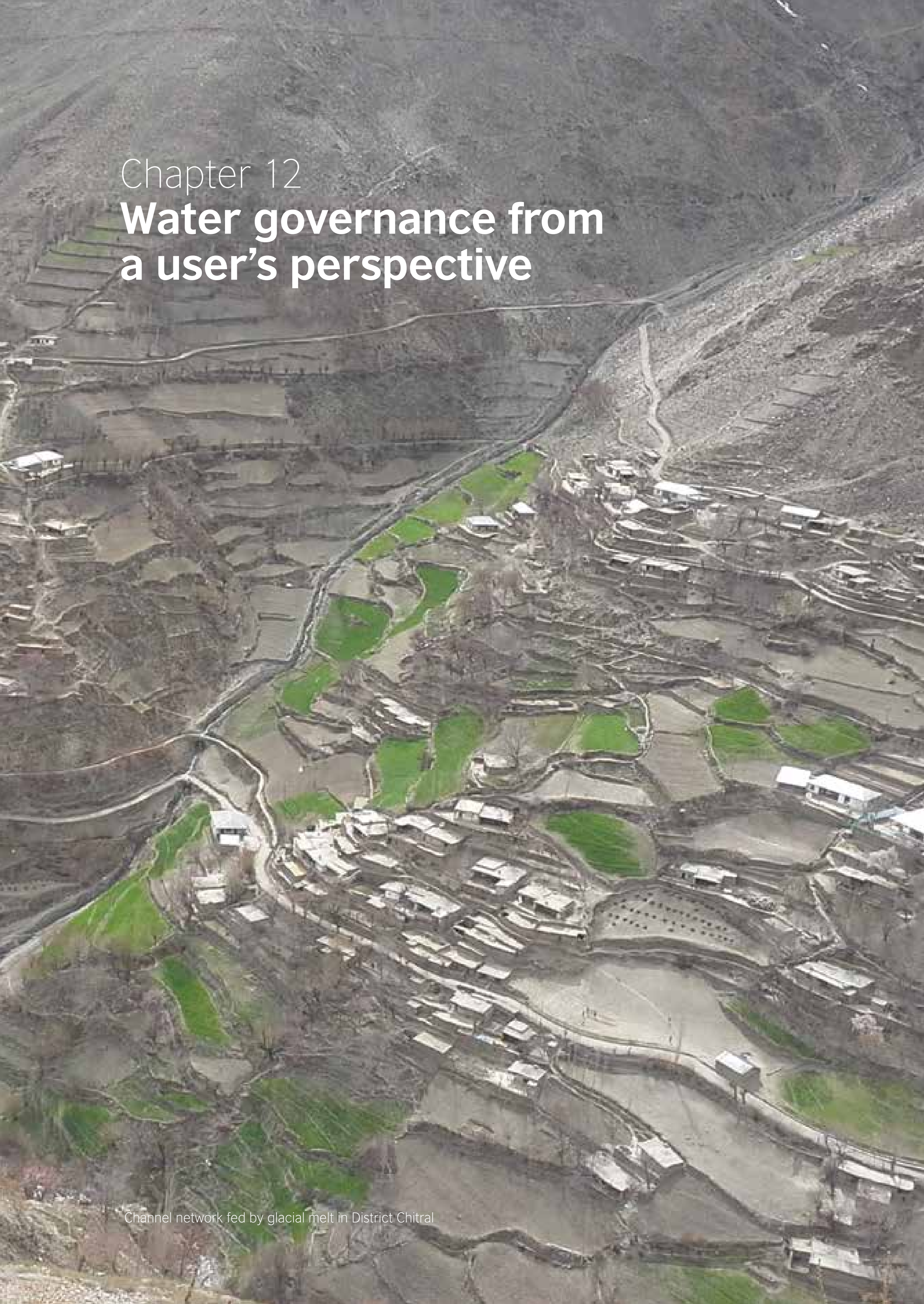
The Pakistan Water Sector Strategy reports that recovery of expenditure in KP was 38%, Punjab 32%, Sind 22% and Balochistan only 12% (GoP, 2002). Another study (Qamar et al., 2019) recommends allocating water to high value crops and to increase price of water. This will encourage farmers to invest more into water saving technologies, thus significantly improving water productivity. The low water price is an important reason for wastage and overuse of water. Qureshi and Ashraf, 2019 also noted that canal irrigation water in Punjab is being supplied to the farmers almost for free, i.e., PKR 135 per acre (PKR 50 for *Rabi* crops and PKR 85 for *Kharif* crops, in terms of *Abiana* rates. This rate is equal to the price of about 4 kg of wheat grain in the market. Thus, practically, the irrigation water has only a nominal price and is almost free compared with the diesel tube well water which costs about PKR 6,000 per acre for wheat. *Abiana* rates have not been revised since many decades. As a matter of fact, the cost of collecting *Abiana* from the farmers is higher than the revenue generated. This has resulted in the deferred maintenance of the irrigation system, further aggravating the situation. Therefore, a rational system of water pricing needs to be introduced.

Another study using data from selected districts of KP, Punjab and Sind and a significant literature review from various countries, contests the general perception of inefficiency in Pakistan's irrigation due to low irrigation water prices (Sahibzada, 2002). This study recommends increasing water supplies to farmers through improved management of the water delivery system and reviewing the centuries old water delivery systems which are inflexible and do not respond to current farming system needs. The study argues that surface water supply deliveries are very inefficient because of losses through seepage and evaporation.

All the studies quoted above, whether they argue for increasing or decreasing water prices, agree that the current water management system is outdated and needs improvement. They further agree that water pricing should be volumetric and based on crop demand, rather than the current system of delivery based on cropping area. In addition, these studies argue for the direct deposit of water fees in bank accounts rather than collection by *Patwaris/Lumberdars* where there are high chances of theft. Furthermore, there needs to be a change from the manual assessment of crops by *Patwaris* towards assessments using appropriate technology that minimises human intervention and omissions.

Chapter 12

Water governance from a user's perspective



Channel network fed by glacial melt in District Chitral

Chapter 12
Water governance from a user's perspective

Tawheed Gul

Water governance refers to the political, social, economic, and administrative systems in place that influence water's use and management[55]. This chapter reflects on the main parameters of water governance in Pakistan, specifically KP province, and where the engagement of water users stands in shaping such governance.

Water governance provides a framework to assess the use and management of water in a holistic way. It provides a means to determine who has access to what kind of water, when and how, and who has the right to water, water-related services, and their benefits. Water governance thus considers the multiple actors having stakes in the water sector and balances water use between socio-economic and environmental activities (i.e. ecosystems). The above definition of water governance provides four fundamental dimensions of water governance as:

- **Social:** the distribution of water resources among different stakeholders and social groups, and the degree to which it is equitable.
- **Administrative:** institutions, their capacities, and their interactions to administer water resources by applying good governance principles.
- **Political:** the regulatory framework such as laws and regulations that govern the water sector
- **Economic:** the efficient use and effective management of water resources.
- **Ecological** is the fifth dimension, often added to highlight sustainable use of water resources and related ecosystems, and to include safeguard mechanisms to maintain ecosystem functions.

A description of the elements of four dimensions of water governance has been given in Table 12.1.

55 United Nations Development Programme (UNDP) and Stockholm International Water Initiative (SIWI), Water Governance Facility: "What is Water Governance", http://watergovernance.org/governance/what-is-water-governance/ (retrieved: 15/02/2017). The Global Water Partnership (www.gwp.org) and SDC use similar definitions.

Table 12.1. Elements of the four dimensions of water governance

Social - Participation and emphasis on social inclusion in terms of multi-stakeholder engagement, gender, upper and lower catchment areas. - Organising dialogues among these participants through the platform of water sector planning in a spirit of IWRM. - Organising water governing community institutions - Enhancing linkages between water sector departments and NGOs to bridge the service provision gaps. - Sensitising stakeholders and awareness raising on water being an important vector of governance. - Conflict mediation and resolution around water.	**Administrative** • Educating water users' associations on managing finances and administering water infrastructures. • Water sector planning to prioritise resource generation • Fund raising, commitment from multiple contributors • Improving operation and maintenance (O&M) skills among water sector players (including community institutions). • Introducing sustainable financial solutions for O&M • Improving management skills and sound engineering techniques
Political - Framing rights and obligations of water institutions including the duty bearers and creating a dialogue - Engaging different stakeholders and actors with diverse roles and responsibilities - Advocacy on entitlements (rights, clarity of ownership but together with responsibility) - Documenting and communicating water laws and frame conditions (*de jure and de facto*) - Recognising traditional water use management systems and documenting this to possibly graft a formal system where necessary - Ensuring access to water for all	**Economic** • Mediating between demand and supply (one water, multi-use) • Enhancing resource potential (increasing source) • Managing water quality • Water infrastructure with environmental and climate change considerations • Ensuring cost effective infrastructure for the maximum number of users • Conducting cost-benefit analysis of schemes • Post infrastructure benefits and productivity enhancement (agriculture, WASH, health benefits)

Water governance may be applied at all levels of water use and management; from the local, even household level, to catchment area, up to national or transnational level. Accordingly, variables such as the characteristics of water resources, involved stakeholders, or socio-economic and political frameworks, vary widely. Despite these significant context-specific variations, interventions in water governance concentrate on strengthening the following levels:

- Individual: Strengthening confidence and capacities of concerned persons and groups to effectively participate in decision-making processes and raising awareness of individual rights and responsibilities.
- Institutional: Strengthening capacities to deliver quality services and products, to respond to citizens' needs while adhering to good governance principles and safeguarding the environment.

- Processes: Strengthening participatory and inclusive decision-making processes about the use and distribution of water resources and related services and creating spaces for dialogue and cooperation among stakeholders.

Lastly, water governance systems and processes are not independent from well-known principles of good governance, which are described below and summarised graphically in Figure 12.1.

Figure 12.1. Principles of good governance

- **Transparency:** The public in general, or at least those directly affected, have direct access to adequate information about the underlying reasons, criteria, intended manner and expected outcome of any decision.
- **Accountability:** Any person or institution, including the state, is answerable for its actions or those under its control. This also implies that clear roles and responsibilities are defined.
- **Participation:** The active, free, effective, and voluntary input to decision-making processes of at least those segments of the population that are directly affected by a process or decision.
- **Inclusion:** No person or group should be excluded from access to power or resources.
- **Efficiency:** Processes and institutions make best use of available financial and human resources to produce expected results, without waste, corruption, or delays.
- **Rule of law:** All persons and institutions, including the state, are subject to laws that are equally and impartially enforced, and are consistent with human rights.

An interplay of all these elements leads to good water governance.

12.1 The role of organised users for efficient use and management of water

The preceding chapters have dwelt on different actors and institutions. An important actor for strengthening water governance is the user. More than the state-led regulations, it is self-governance by users that brings about judicious use of water and appropriate management.

Lack of sufficient water for drinking and irrigation is a key driver of poverty in water scarce areas. People in ecologically fragile areas (e.g. high mountains, dry areas) face risks every day and need effective coping strategies due to their high vulnerability to droughts and floods at different times. In the absence of a reliable drinking water supply, the suffering of women and children increases. In addition to lack of access, a big issue is dysfunctional or malfunctioning water supply schemes. Hence even where investments have been made, water supply schemes that have not been properly maintained fail to benefit communities on a long-term basis. With over sixty years of history of government-led support for water through several highly organised and well-staffed departments, communities in many areas are still suffering from water related issues. The missing element is a lack of community involvement in water supply planning, implementation and post-construction operation and maintenance (O&M). As a result, there is a lack of ownership amongst the beneficiaries of these schemes.

Traditionally, communities are seen only as recipient of public services provided with taxpayers' money. Several examples in Pakistan and around the world suggest that formal and regulated community participation increases access to water and enhances changes for the proper O&M of infrastructure schemes (Ananga, 2015; Nizami and Khattak, 2014; Marks, Komives and Davis,2014; Boakye and Akpor, 2012). There are examples of improved access to drinking water for additional beneficiaries with community participation compared with schemes in a similar context with no participation of communities (Aga et al., 2017; Madajewicz et al., 2015; Madajewicz et al., 2007).

A few examples are reported from Pakistan where communities have been engaged as water users in managing water within their limited means and rich traditional culture.

1. **Cluster organizations formed by different projects and programmes**
   Since community needs evolve over time, it is essential to ensure that institutional arrangements are in tune with the specific realities of local communities. For that purpose, different rural support programmes and integrated development projects follow a strategy focusing on capacity development, financial asset creation and trust building. The concept of supporting the formation of different forms of cluster or apex organizations of communities as a second tier of project implementation emerged from the carpet approach of developing Community Based Organisations (CBOs) in villages. In many villages CBOs are managing their natural resources including water resources and micro hydel projects. There are multiple examples of different constructs of cluster CBOs serving as effective institutions, covering large geographical areas, supporting development, and building linkages and partnerships with public-sector institutions at a higher level, private sector agencies and other development partners. They have a role in defining the rules and regulations for the O&M of infrastructure schemes including water related projects. This enables communities to maintain these schemes in a sustainable manner.

2. Water Users' Associations by On Farm Water Management Department

The Water Users Associations (WUAs) were established in 1970. To register a WUA, more than 50% of the water users have to apply to the On-Farm Water Management Department (OFWMD).

Initial legislation for governing the irrigation network in the Indus Basin was passed by the British during the colonial era. According to the Canal and Drainage Act, 1873 in Punjab and KP and the Sind Irrigation Act 1879, the provincial governments are responsible for the construction and major repairs of watercourses, while overall maintenance of the watercourses is the responsibility of the users. For more than a century, farmers and irrigation officials have relied on traditional form of farmers' organisations called *khal* committees to mobilize labour during the maintenance of watercourses. However, there has been an increasing realisation that these informal water users' associations have not been effective in maintenance activities. Studies documenting the experiences of the OFWM pilot projects led to the conclusion that legally recognised and empowered WUAs are more effective in maintaining water courses (Byrnes, 1992). Consequently, in 1981, three provinces (Punjab, KP, and Baluchistan) promulgated their own WUA Ordinances while the Sind province promulgated WUA Ordinance in 1982.

According to these Ordinances, WUAs are empowered to improve, rehabilitate, operate, and maintain watercourses; establish water delivery schedules and supervise water allocation and distribution; ensure all members get their share of water in a timely manner; remove obstructions on courses; employ labour for O&M; and ensure that all members contribute. The provincial authorities could curtail some or all of these powers of the WUAs. In 1997, the Irrigation and Drainage Acts were passed in all four provinces and Irrigation and Drainage Authorities were established. These authorities were meant to be autonomous, responsible for supplying water from the barrages to the canals. As per the Irrigation and Drainage Authority Act 1997, Area Water Boards were to be formed for every canal and Farmer's Organisations were to be formed for every distributary. The responsibility of the Area Boards is to collect revenue from the water users (farmers) and transfer it to the Irrigation and Drainage Authorities.

The Irrigation and Drainage Acts do not mention WUAs at the watercourse level. Hence the formation of such WUAs continued to be governed by the WUA Ordinances promulgated in 1981 and 1982. Despite legislation, the transfer of water management to WUAs has not taken place mainly due to opposition from powerful political stakeholders and a prevailing belief that WUAs cannot be trusted to manage water. Therefore, much of the irrigation network is still being governed through British era legislation, except on the canals where Area Water Boards exist. Some actors within the government, however, realise that handing over the irrigation management activities to the WUA can improve timely and adequate water delivery, the recording of the irrigated area, revenue collection and even dispute management.

3. Water Users Association in four districts of KP

The Water for Livelihoods project (2011-2020), a bilateral initiative of the Swiss Agency for Development and Cooperation (SDC) and the Government of KP under the umbrella of the Planning and Development Department, conducted Integrated Water Management Planning (IWRM) in four target districts of Chitral, DI Khan, Karak and Tank. The project was implemented by Helvetas Swiss Intercooperation. The IWRM plans were prepared jointly by the relevant district governments and water users. During the process of plan preparation, Water Users' Associations (WUAs) were established in the four districts as co-owners of the plans along with the district governments.

An already existing WUA concept was piloted as a democratic and participatory concept. The overall principles of WUAs include:

- WUAs are legally recognised bodies under a relevant legal cover suitable for the specific catchment.
- WUAs have emerged / grown out of village-based water user and community groups and are not independent or parallel in nature.
- WUAs are neutral – that is, non-partisan.
- WUAs participate in the process of IWRM plan formation and actively include their fellow communities in the process.
- Initially established at tehsil level, the WUAs will grow at district level.

This concept is inspired by the traditional *Rudh Kohi* irrigation management system in parts of KP, Punjab and Balochistan under which water users (named differently in different districts) were responsible for the management of water and the collection of funds for the maintenance of the irrigation network. The WUAs pooled their financial, technical, material, and human resources for the operation and maintenance of a water system. The WUAs have elected leaders; handle disputes internally, collect fees, and implement maintenance. The newly evolved WUA concept is inclusive, having women, vulnerable individuals, youth, landless and poor in the association. The bylaws made for WUAs have been approved by the provincial government. The members play a role in decision making, raise their voice, express their opinions and vote during the IWRM planning and implementation. While executive members are elected to perform duties, the real authority rests with the general assembly of water users. In all cases, monitoring and supervision of water infrastructure is conducted by the WUAs. The maintenance is handed over to the O&M committees established by the WUAs.

One beauty of the WUAs is the ability to handle disputes at local level. This avoids cumbersome legal processes in the judicial system and improves accountability among the members. The members are from the community and have a moral obligation to mediate disputes in a just manner knowing they may be in a similar situation in the future. This is also appreciated by the authorities since every little dispute ending at their doorstep cannot be handled by them and only becomes chronic and a drain on time in resolving them.

The WUA has been instituted as a fifth layer of water sector implementation in the KP province IWRM strategy. These associations are to be established as a precondition to preparing IWRM plans, thus assuring their participation in the process. The strategy obliges WUAs to have at least 30% women as members. The role of community participation in water management has been recognised in the National Water Policy 2018. This is very encouraging as a way forward for all public-sector organisations in designing a comprehensive community engagement strategy. Without having a clear implementation strategy for engaging all stakeholders, the National Water Policy 2018 may not produce results. This combined strategic designing of IWRM is a significant step forward in the efficient and effective implementation of the National Water Policy.

Key challenges in users' participation and obligations

1. The role of communities/beneficiaries is critical at two levels i.e. water conservation and management. The farmers follow the irrigation schedule and are considered users, not managers of water; therefore, their role does not include water conservation. The WUAs formed under the different initiatives in KP are dormant as there is little ownership created among the farmers. This is because the purpose of WUA formation has been restricted to the construction of irrigation channels and minor canals. As soon as the projects were completed, the purpose was served and the WUAs had no further mandate.
2. The policies and rules are very well thought out and designed. The real problem in the water sector, however, lies in implementation and the lack of a clear strategy for the engagement of local communities/beneficiaries. Beside this, the office bearers/officers of the government departments have little time and means to engage with communities/beneficiaries or to include them regularly in meaningful discussions and dialogue in water decision-making.
3. Organising local communities in urban settings is one of the biggest challenges in water resource management.
4. Every water project has an important technical component. However, there are social aspects of sustainability; without their integration, it is likely that the project will face post-construction O&M issues and/or the benefits will not fully reach all the users in an efficient manner.
5. Currently the private sector is a user of all sources of water including both canal and groundwater (directly or indirectly such as through producing bottled water or beverages, through buying agricultural products, and other industrial uses). Yet often this use comes with hardly any obligations to invest in water productivity. Indeed, the private sector is not generally recognised as a user. Hence there is no space for its formal engagement in contributing to effective water governance nor does it have any clearly laid out obligations.

Chapter 13

Policy landscape in the water sector

Lake Lulusar, District Mansehra

Chapter 13
Policy landscape in the water sector

Muhammad Ashraf
Arjumand Nizami

Policies provide guiding principles to achieve intended objectives. It is through good policy that governments address the problems faced by the people they are elected to serve. Pakistan has a good record in policy making. However, policy implementation has been a challenge. Various factors explain the weak implementation including insufficient or irrelevant financial allocations, lack of capacity, poor policy evaluation, political economy and monitoring systems, a centralised approach to implementation and weak institutional structures. After the 18th amendment to Pakistan's constitution, policy making in several areas including education, health and local government was devolved to the provinces. The provinces are also expected to develop their own policies and strategies for the sustainable management of water resources. This chapter analyses the policy landscape in Pakistan and KP province regarding water and related sectors. Although several of these policies have already been discussed in preceding chapters, this chapter brings together in one place all the major policies and strategies that impact water in Pakistan. The policy landscape is discussed under four major headings, as follows:

- National multi-sectoral development strategies / visions
- National sectoral policies and strategies related to water
- Provincial multi-sectoral development strategies / visions
- Provincial sectoral policies and strategies related to water

1. National multi-sectoral development strategies / visions

These strategies and policy related documents serve as an important reference in the water policy landscape and set an overall frame of sustainable development in the country and the province.

Vision 2025 – Government of Pakistan

This very important document has seven pillars, the fourth being on Water, Energy and Food Security. Vision 2025 makes access to an adequate supply of water for all uses and users a top priority. It describes the following five goals for water security in the country:

1. Increase water storage capacity, applicable to the requirements of each province, in line with defined strategic needs and international benchmarks: from currently 30 days to 45 days by 2018, and 90 days by 2025.
2. Invest in proven methods and technologies to minimise wastage (e.g., in the agricultural sector), promote conservation and gain efficiencies through the rationalisation of pricing.
3. Enable more effective allocation with direct reference to national and provincial priorities and related social and economic considerations.
4. Establish institutional mechanisms (e.g., a National Water Commission) to effectively

manage all sources of water (surface, sub-surface, precipitation) and their sectoral and regional allocations (agriculture, industry, urban).

5. Provision of access to a minimum baseline of suitable water to every person in Pakistan.

Although the intent was important, the goals envisaged in the Vision 2025 could only partially be achieved. The National Water Commission which was supposed to manage the water resources could not be established.

National Initiative for Sustainable Development Goals (SDGs)

Goal 6 of the SDGs is on Clean Water and Sanitation. The process of implementing the SDGs in Pakistan has been more than just agreeing to formal arrangements with government partners. It has also been an inclusive process relying on evidence-based solutions to transform abstract SDG aspirations into real and objective targets for all stakeholders, including local actors. The 18^{th} constitutional amendment devolved several public functions, including the provision of social services, from the federal to the provincial governments. The consultation process with all the stakeholders for coordinating and strengthening efforts at federal and provincial levels led to determine Pakistan's sustainable development and poverty reduction targets. This included defining measures for improved data collection and the enforcement of monitoring mechanisms. National and provincial SDG Support Units have been established to ensure the early institutionalisation of SDGs, providing coordination and advisory services to the respective ministries and line departments. The initiative brings together the planning, financing, and statistical institutions to work collectively in laying the foundation of SDG implementation across the country.

However, even after laps five years, no baseline information has been established regarding SDG 6 and its indicators, mainly due to scanty data, lack of coordination among the institutions (both at federal and provincial levels), lack of understating about SDGs, lack of capacity and allocation of insufficient financial resources. With the present pace in Pakistan, experts fear that Pakistan would not be able to achieve SDGs, particularly the SDG 6.

National Food Security Policy 2018

National security of any country is linked with its food security and Pakistan is no exemption. However, in spite of being an agrarian country, Pakistan did not have its food security policy until 2018. As food security is directly linked with water security, the policy has a complete chapter on land and water resources management with multiple measures to reduce groundwater depletion, harness rainwater potential, reduce losses and improve water productivity in agriculture through climate-smart solutions. The availability and management of water for agriculture and other food-related activities is crucial for securing food security. The National Food Security Policy recognises that food security in Pakistan is still a key challenge due to high population growth, rapid urbanisation, low purchasing power, high price fluctuations, erratic food production, and inefficient food distribution systems. Food insecurity in Pakistan is primarily attributable to limited economic access to food amongst the poorest and most vulnerable. A key factor limiting access to food, particularly since 2007, is an increase in the price of essential food items. The policy recommends improved food availability and resilient agricultural growth, especially in rainfed areas.

2. National sectoral policies and strategies related to water

National Water Policy, 2018

Pakistan's first National Water Policy (NWP) was approved in 2018. Water is the most important issue in Pakistan due to the country's economic reliance on agriculture. It is, however, also the most contentious resource in nature due to an increasing scarcity, which explains why it took decades to agree on a national water policy.

Though there are some critics of the National Water Policy, yet it is a national consensus document which can be used as a guiding principle. It is generally agreed that this highly awaited policy helps to raise awareness on the importance of water, gives serious direction to the provinces for the integrated management of water resources, and starts a discussion on a water secure future which is much needed for future generations.

With the slogan of 'more crop per drop', the NWP recognises the importance of water for Pakistan's future and the challenges that lie ahead. The policy emphasises the need for the conservation of available water, improving water use efficiency, increasing water storage capacity through providing more infrastructure, taking advantage of technologies in all aspects of water (conservation, storage and effective usage), the use of renewable energy, efficient and sustainable use of groundwater, integrated water resource management and establishing a comprehensive regulatory framework for the water sector.

Strategically, the policy highlights, among other measures, a national master plan for water storage i.e., the construction of large, medium, and small dams not only to generate clean energy but also to provide a reliable source of water for agriculture and other human needs. Thus, the policy sets a target to enhance the existing water storage capacity of 14 MAF up to 24 MAF. It seeks to promote a trend in which the management of water resources shifts from a sectoral to a more integrated approach. Within an integrated approach, the interests of all upstream and downstream stakeholders may be protected including the protection of watersheds to prolong the life of water storage facilities. The integrated approach will, however, require the strengthening of institutional and management capacity at all levels by creating an enabling environment for active stakeholder consultation and participation. This includes provision for water users' institutions to perform an effective role in efficient water utilisation.

The NWP is based on the concept of integrated water resource management IWRM. The policy lays down a broad framework and set of principles for water security to guide the provincial governments in formulating their respective Master Plans and projects for water conservation, water development and water management. The primary policy objectives of the NWP are to promote sustainable consumption and production patterns; improve the availability, reliability and quality of freshwater resources to meet critical municipal, agricultural, energy, security and environmental needs; and improve urban water management by increasing system efficiency and reducing non-revenue water through adequate investments to address drinking water demand, sewage disposal, handling of wastewater and industrial effluents. An important characteristic of the NWP is that it calls for the participation and engagement of all stakeholders for the effective and efficient utilisation of water resources. It also acknowledges the importance of behavioural change in reducing the wastage of water.

Nevertheless, implementation of the NWP like many other policies would be a great challenge. A mechanism has been proposed in the NWP for its implementation that consists of a National Water Council (NWC) to be chaired by the Prime Minister and a Steering Committee (SC) with Secretariat at the Ministry of Water Resources (MoWR) to be chaired by the Federal Minister. The NWC must meet at least once a year and the SC at least twice a year. However, during the last more than three years, only one meeting of the NWC was held whereas no meeting of the SC has been convened.

National Power Policy, 2013

The National Power Policy, 2013 (NPP) envisages that "Pakistan will develop the most efficient and consumer centric power generation, transmission and distribution system that meets the needs of its population and boosts its economy in a suitable and affordable manner". The following are some of the goals set by the government of Pakistan for achieving the long-term vision of the power sector:

- Build a power generation capacity that can meet Pakistan's energy needs in a sustainable manner.
- Ensure the generation of inexpensive and affordable electricity for domestic, commercial, and industrial use by using indigenous resources such as coal and hydel.
- Promote world class efficiency in power generation.
- Create a cutting-edge transmission network.
- Minimise inefficiencies in the distribution system.
- Align ministries involved in the energy sector and improve governance of all related federal and provincial departments as well as regulators.

Most of the goals set in the power sector policy pertain to power generation either from hydel or thermal and other resources, and efficient transmission and distributions. Yet many directly or indirectly hint at the conservation of hydropower to ensure a sustainable, inexpensive and affordable power supply. Similarly, it is a long-term priority of the government to start and bring up public-private partnership (PPP) projects in hydropower, finish large infrastructure hydro projects and retire high cost energy contracts.

National Climate Change Policy, 2012

The National Climate Change Policy, 2012 (NCCP) addresses the importance of conserving water resources in response to the changing climate. The objectives of the NCCP include, *inter alia*, ensuring water security, food security and energy security in the country in the face of climate change challenges, and promoting the conservation of natural resources and long-term sustainability. The policy also provides a comprehensive implementation framework through provincial governments. The goal of the policy is "to ensure that climate change is mainstreamed in the economically and socially vulnerable sectors of the economy and to steer Pakistan towards climate resilient development". Objectives 4 and 5 of the National Climate Change Policy pertain to water resources (GoP, 2012). These are:

- To ensure water security, food security and energy security of the country in the face of challenges posed by climate change.
- To minimise the risks arising from the expected increase in the frequency and intensity of extreme weather events such as floods, droughts, and tropical storms.

As a follow up of the NCCP, a "Framework for the Implementation of Climate Change Policy 2014-2030" was developed with a focus on climate change adaptation, mitigation and resilience building. There is a complete chapter on water sector adaptation actions. It has proposed various strategies for water conservation, rainwater harvesting, enhance public awareness, development of IWRM, groundwater management, wastewater recycling and reuse, watershed management, capacity building, development of regulatory frameworks etc. with long, short, and medium-term priorities.

National Drinking Water Policy, 2009

The National Drinking Water Policy (NDWP) was approved in 2009. According to the NDWP, provision of safe drinking water is a fundamental human right and the responsibility of the state. The main objective of the policy is to provide adequate quantity of safe water to the entire population at an affordable cost and in an equitable, efficient and sustainable manner by 2025. The policy has also provided guidelines for the protection and conservation of water resources, appropriate water treatment technologies and standardization, capacity building, public awareness and legislation etc.

National Environment Policy 2005

Environment has profound impact on the quantity and quality of water. The National Environment Policy (NEP) was approved in 2005 with the aim to protect, conserve and restore Pakistan's environment in order to improve the quality of life of the citizens through sustainable development. The policy provides guidelines for water supply and management, air quality and noise, waste management, forestry, biodiversity, climate change and ozone depletion, energy efficiency and renewable energy etc. The Ministry of Environment was the custodian of the NEP. However, after the 18th amendment to the Constitution of Pakistan, the subject was devolved to the provinces.

National Forest Laws/ Policies

The major forest acts were promulgated in the colonial era, their origin dating to the late 19th century. Such legislation was primarily designed to serve the purpose of the colonial regime to manage the Reserved forests by keeping the people away from them, ensuring forest protection through an enforcing and policing role of the forest functionaries and making provisions for and strictly implementing their punitive clauses. The same set of regulatory laws were not only continued following creation of Pakistan in 1947, but were extended to Protected forests, Guzara forests and Privately-owned wastelands.

The National forest policies 1955, 1962, 1975 and then 1981 were proclaimed as part of national agricultural policies. The 1955 policy had the major objective of increasing the area under forests and managing forests for their protective function through the preparation of management plans of declared forests and promoting private forests. Another forest policy statement was passed in 1962 which provided more definite instructions on increasing the forest area and gave precedence to the commercial aspects of forestry. This policy recommended that provincial governments should progressively acquire local use and free grazing rights. A new forest policy was then adopted in 1975, entrusting the management of Guzara forests to the owners themselves, with the government taking only supervisory responsibilities. The policy allowed for the formation of "owners' cooperative societies" and recommended that forest harvesting should be carried out entirely by public sector agencies. Forest policy was further revised in 1981, this time suggesting conservation-oriented measures including the planting of fast-growing species and energy plantations outside public forests and encouraging people's participation. The main objective set forth by the forest policy formulated in 1991 was to meet the country's environmental and commercial needs by increasing the forest area to 10% in fifteen years using a social forestry approach, among others. The 2001 policy promoted stricter control over forests, encompassing all renewable natural resources of Pakistan (forests, watersheds, rangelands, wildlife, biodiversity, and their habitats). The latest policy was notified in 2015 with objectives to enhance public awareness on the economic, social, ecological, and cultural values of forests with mass afforestation programmes to expand and maintain forest cover, and strict control on deforestation. The policy also speaks of reducing the carbon footprints of energy and economic programmes.

3. Provincial multi-sectoral development strategies / visions

Khyber Pakhtunkhwa Economic Growth Strategy 2015

The Economic Growth Strategy 2015 of KP province focuses on stimulating the growth of high potential sectors of the economy through enhanced public investments and complementary sectoral policies. The strategy is an attempt to take stock of the drivers of future economic growth and to outline challenges in reaching the goals. The future economic growth rate is likely to be driven by urbanization, trade and connectivity, remittances, fiscal transfers and tourism. KP province has immense potential as a regional trade centre as well as being a prime location in terms of transit trade across geographical borders. The prioritised growth sectors comprise manufacturing, construction, agriculture and livestock, mining and tourism. Agriculture remains the most important sector in the provincial economy since it employs most of the labour force. In order to fully utilise the potential of this sector, certain steps such as the diversification of crops, development of seed nurseries, and rational utilisation of water need to be taken. The strategy calls for the consideration of rainwater harvesting by building small dams in water catchment areas in addition to building new water infrastructure and improving the old ones. A switching towards less water-intensive crops such as fruits, vegetables, and pulses is also indicated.

Khyber Pakhtunkhwa Comprehensive Development Strategy, 2010

The government of KP province developed a Comprehensive Development Strategy (CDS) in 2010 for all development sectors, including agriculture. In this respect, the CDS aimed at improved production through better extension and research services, the availability of certified seed and fertilizer, and a reduction of distortions in distribution. It also encouraged greater commercialisation through improved efficiency of agricultural markets and maximised incentives for farmers, prioritising public private investment in market, processing and storage facilities. Linked to this, it sought increased farmer co-operation and participation, the facilitation of private investment in livestock, fruit, water management and dairy, expanded agricultural credit, diversification to higher value products, investment in post-harvest handling, improvements in the efficiency of water use; and the bringing of cultivable wasteland into farming through provision of irrigation and land development.

4. Provincial sectoral policies / strategies

Integrated Water Resource Management (IWRM) Strategy, 2019

As noted in previous chapters, KP province has a high incidence of multi-dimensional poverty. This is linked to lack of access to clean drinking water and irrigation to expand cultivable lands. Therefore, engaging in water sector development for improved access to water is a key driver for improving the well-being of the people. The National Water Policy, 2018 suggests that the provinces develop their own water-related strategies including integrated water resource management (IWRM) strategies. The IWRM approach takes water as one shared, finite, and economic entity, which is a highly relevant concept for KP with its diverse landscape.

The IWRM strategy of the KP province was approved in 2019. It recognises all competing uses of water, the respective challenges and past attempts to bring about the equitable access of water resources by all sectors. The strategy recognises water as a precious economic good, encouraging its rational use. The core rationale is to maximise economic development and social welfare in an equitable manner through the judicious use of available water resources. The strategy upholds the integration of natural (quality, quantity, type, nature) and human systems (sectoral demands and supply, coordination, participation) without compromising the sustainability of vital ecosystems. It argues that improved coordination for the rational and efficient use of water resources will lead to reduced costs of water management and increasing revenues. The strategy also strongly supports the inclusion of water users in decisions over water resource management by providing an institutional infrastructure and systematic planning mechanism.

The overall goal of the IWRM strategy is the coordinated development and management of water and land resources in a sustainable and equitable manner for the greater provincial interest and welfare of the people of KP. It aims to optimise the economic, social, and environmental returns on water resources, ensure equitable allocation among competing demands, promote judicious use by consumers, and ensure safe disposal of post-use effluents. The strategy has four main pillars, twelve priority areas and one hundred action lines. In seeking to engage users, planners, and policymakers at all levels, the structure of its implementation framework is congruent with the structure suggested in the national water policy.

The Khyber Pakhtunkhwa Draft Water Act 2020

One of the most important policy documents that KP government has prepared is draft Water Act 2020. The purpose of the Act is to comprehensively manage and regulate water resources in the KP, in the interest of conservation and sustainability. It proposes to establish a KP Water Resources Commission with members from all the line departments and related experts. The main function of the Commission is to take policy decisions regarding water conservation, redistribution and its augmentation, allocation of water resources for various sectors (domestic, industry, agriculture, ecosystem services). The Act also proposes to establish a KP Water Resources Regulatory Authority under the Chairmanship of the Additional Chief Secretary of the Province. The main function of the Authority is to regulate the service providers, approve, determine and revise tariff for water and sewage services providers. The Act has also provided a set of guidelines for the service providers for efficient use of water and its quality protection.

The main focus of this Act is to regulate service providers for domestic and sewage waters. However, there is no focus on groundwater management, rainwater harvesting (though a substantial area of KP is rainfed), *Rudh Kohi* (Spate) irrigation system and watershed management. Moreover, no or little emphasis has been given on the efficient use of water in the agriculture sector – a sector using maximum water.

Khyber Pakhtunkhwa Hydropower Policy, 2016

Pakistan, and specifically KP province, is bestowed with enormous hydropower potential which, if exploited in a systematic, planned, and transparent manner, can ensure energy security on a sustainable basis. The hydropower policy, 2016 emphasises environmental integrity whilst offering profitable business opportunities, modern engineering and technical processes, and lower costs of doing business in order to attract local and international investors in hydropower development. The main objectives of the policy are to provide least-cost power generation and green energy, private sector investment through full cost recovery and attractive rates of return, fast track and transparent development of power projects, the full participation of investors in the development and implementation of hydropower projects, as well as broader stakeholder participation.

The policy is important for water sector projects in relation to the IWRM strategy as hydro power generation is one of the most vital uses of water for economic and developmental purposes. The policy acknowledges the importance of multi-stakeholder planning and emphasises the welfare of all stakeholders. It encourages investment through public, private, and public-private partnerships. It requires a detailed environmental and social impact assessment of the projects, to be carried out as per rules laid down in the Provincial Environmental Protection Act, 2014 relating to National Environmental Quality Standards.

Khyber Pakhtunkhwa Local Government (Amendment) Act, 2015

This is an amended Act of 2013, as result of the enactment of the Khyber Pakhtunkhwa Local Government Act 2015, a three-tier local government system has come into place. The third tier is the Village Council (VC) or Neighbourhood Council (NC). The third tier has the following roles:

- Improving water supply sources, maintaining a water supply distribution system, and taking measures to prevent water contamination.
- Monitoring and supervising the performance of functionaries of all government offices located in the respective VC or NC, including education, health, public health engineering, agriculture, livestock, and revenue.
- Planning and implementing arrangements for sanitation, cleanliness, drainage, and sewerage system.
- Mobilising the community to maintain streets, culverts, bridges, and public buildings.

Khyber Pakhtunkhwa Drinking Water Policy, 2015

The first KP Drinking Water Policy, 2015 provides an institutional and legal framework for achieving its objectives. The policy adopted the key principles outlined in the National Drinking Water Policy, 2009 and is aligned with the National Environmental Policy, 2005 and SDG 6.1. Its overall goal is to streamline the sector and ensure that by 2025, the entire population of KP will have access to an adequate quantity of potable water at an affordable price through the provision of equitable, efficient and sustainable services. The policy sets out the approaches to be taken, and the roles of all stakeholders. For example, it clearly indicates that “small and technologically simple schemes constructed by the Local Government and Rural Development Department out of district government funds, shall be handed over to the concerned beneficiaries for operation and maintenance”. One of the important features of the policy is the allocation of at least 10% of the provincial ADP (Annual Development Plan) for the achievement of its goal and objectives. Moreover, the policy also proposes to establish Drinking Water Act and Water and Sanitation Regulatory Authority to comply with the National Drinking Water Quality Standards and National Environmental Quality Standards (NEQS). However, such approaches and designated roles need further elaboration, with a clear implementation strategy, for the real engagement of all actors - especially regarding the role of the community and individual beneficiaries.

Environmental Protection Act, 2014

The Environmental Protection Act is an important instrument for provincial water management, especially concerning water quality – on which the Act contains several clauses. A few examples are as follows:

- Section 4(vi). Provide guidelines for the protection and conservation of species, habitats, and biodiversity in general, and for the conservation of renewable and non-renewable resources, solid waste management, water and sanitation.
- Section 6(1)(vii). Establish standards for the quality of the ambient air, water, and land, by notification.
- Section 6(1)(Xxiii). Promote public education and awareness on environmental issues through mass media and other means including seminars and workshops.
- Section 11(1)(i). No person shall discharge or emit or allow the discharge or emission of any effluent or wastes or air pollutant or noise, load, concentration or level which is in excess of the Khyber Pakhtunkhwa Environmental Quality Standards or, where applicable, the standards established under sub clause (vii) and (viii) of sub-section (1) of Section 6.

Khyber Pakhtunkhwa Agriculture Policies (2005-2010 and 2015-25)

The agriculture sector has always been a development priority for the KP government. The first ever agriculture policy was adopted by the provincial government in 2005. It mainly focused on the introduction of participatory technologies, strengthening coordination and service delivery systems, research and development, creating an enabling environment for the private sector investment, and upgrading and strengthening existing legislation. Within agriculture, the horticulture sub-sector occupies an important space due to its high potential in the province, with its diverse agro-climatic conditions. KP province leads all other areas of Pakistan in its fruit and vegetable production. This may be attributed to a long-term, precedent-setting Project for Horticulture Promotion (PHP) supported by the governments of KP and Switzerland that was implemented by Intercooperation – IC (now Helvetas Swiss Intercooperation) over 1987-2004. With PHP support, the province's Horticulture Policy, 2009 was developed, declaring horticulture as an industry. The priorities of the policy were improved public/private partnerships, the reorientation of research and development, improved efficiency and profitability of horticulture, and market development.

The KP Agriculture Policy, 2015-25 is another important milestone, and was developed with the active support of FAO. The guiding principles of this policy are building on local skills and tradition, involving all stakeholders to serve the farmer, creating a "fit for purpose" public support system, building human resources and factoring in climate change and disasters. The new agriculture policy of KP envisages the support and promotion of sustainable agriculture as an inclusive and dynamic source of economic growth and development and a producer of food, income, and employment. The key players identified for implementation of the policy are the private sector, NGOs/CSOs, government and farmers. This multi-stakeholder approach, with clear roles and responsibilities, is expected to substantially increase the implementation rate of specific action items in the policy.

The Irrigation and Drainage Authority Act, 1997

The North-West Frontier Province Irrigation and Drainage Authority Act, 1997 was part of a strategy for streamlining the irrigation and drainage system in the province. It also aimed to make the administration of the system more responsive and efficient and to attain economic effectiveness and sustainability of irrigation, drainage, and flood control systems, respectively.

The Rural Area Drinking Water Supply Scheme Act, 1985

Under the law, the planning of rural area drinking water schemes is vested in the Department of Public Health Engineering (PHED). The role of PHED within this law is limited to the planning and construction of schemes. The management and maintenance of the schemes falls under the responsibility of the Local Government and Tehsil Municipal Administration. An important lacuna is that while PHED is responsible for the construction of public drinking water schemes, their electrification requires approval from WAPDA or the concerned electricity supply corporations. This results in significant delays (often up to 2-3 years), by which time the scheme has already begun to deteriorate. The Act further prohibits the damage or disruption of water supply schemes and identifies penalties, rates, and other such measures in case such damage is caused intentionally; application procedures for water connection; disconnection of water supply; appeals; etc. It further identifies the conditions and process for water supply disconnection and prohibits drinking water being used for irrigation purposes (for which there are penalties). Importantly, however, such penalties are seldom levelled although the use of drinking water for irrigation is not uncommon in rural areas.

The Canal and Drainage Act 1873 (Federal & Provincial)

This law, enacted in 1873, was applicable to the united India (including current Pakistan) and later amended and extended on several occasions to meet the emerging and complicating needs following independence and later. According to the Act, the provincial governments are the owners and managers of the canal water and drainage infrastructure at the primary and secondary levels. The law is divided into several parts. Part 1 mostly presents definitions of canals, works, watercourses, drainage work and clarifies different designations. Within a district, the Executive District Officer (Revenue) is designated to implement the powers provided by the Act. It concerns only the government and office bearers, and lacks any reference to the role of communities or water users and their associations.

Forest laws in Khyber Pakhtunkhwa

Since colonial times, the Forest Departments have been structured in a strict hierarchy. In KP this structure was changed in 2002 under a new forest law. It is now organised in a matrix structure, with five specialised units: Directorate of Forestry Planning and Monitoring;

Directorate of Community Development, Extension, Gender and Development; Directorate of Institutional and Human Resource Development; Directorate of Research and Development; and Directorate of Non-Timber Forest Products. The KP Forest Ordinance, 2002 was enacted in 2004 and served to consolidate and amend all colonial forest laws. The Act advocates the adoption of an integrated, participatory approach, although its implementation remains administratively challenging. It introduced a three-stage planning process for forest management, a Forest Development Fund, and a forest force. Of these innovations, the three-stage planning has been achieved to some extent. Organised through a Forestry Management, Planning and Monitoring Circle, it includes the establishment of village development committees and Joint Forest Management Committees depending on the legal category of the forests concerned. In order to revitalise local participation in forest management, the Community Participation Rules, 2004 established a legal basis and renewed the mechanism of organising Village Development Committees/Joint Forest Management Committees to involve stakeholders in the management of forests and land-use. Integrated land-use planning is supported in the new policy through working jointly with the Departments of Agriculture, Livestock, and Local Government. This is guided through an officially adopted village planning manual and guidelines.

KP River Protection Ordinance, 2001

The River Protection Ordinance, 2001 aims to protect the aquatic ecology, water quality, economic and environmental value of rivers and their tributaries in KP province. According to the Ordinance, specific rivers and streams are notified under official Gazette as falling under legal protection, allowing for controlled land use and zoning of the catchment areas. In particular, the area bounding such rivers or streams, which may stretch from 200 ft to 1,500 ft, is designated as a Provincial Control Area (PCA), under which all developmental works are controlled. The purpose of the ordinance is that the river and its tributaries are a public resource and property, and are to be used by people for drinking, irrigation, commercial and recreational purposes after lawful permission, showing water use rights.

The KP Water Users' Associations Ordinance, 1981 (amended 1987)

Under this ordinance, the On-Farm Water Management Department has registered 28,311 Water Users' Associations (WUAs). The ordinance provides for the formulation, operation, and provision of water users' associations in KP province and related matters. The WUAs work for the improvement of both water supply (from surface or groundwater sources), and on-farm water management for agriculture. The scope of this law is confined to the construction of water courses and their management. It does not cover any other aspects of water - neither drinking nor other irrigation systems. It also makes no mention of the institutional development and capacity building of the WUAs.

Kulyat and Rewajat, 1906 (Spate irrigation system)

The Spate irrigation system[56] has been practiced in the area for centuries. Water rights in larger systems of the Suleman Range of Pakistan (DI Khan and DG Khan) were documented by the British Revenue Administration in registers called the *Kulyat-e-Rewajat*.

The settlement process in the DI Khan spate area (locally called *Rudh Kohi*)[57] started in late 1808 and was accomplished by 1908. Customary water rights were codified by the colonial district administration in 1905 in the form of *Kulyat and Rewajat-e-Abpashi* (*Abpashi* mean irrigation). These registers are still consulted and contain the lists of all villages responsible for the labour in each bund[58]. In KP, spate irrigation is practiced in DI Khan, Tank, Kohat and Karak districts. This law is an amalgamation of both court laws (*Kulyat*) and customary (*Rewajat*) law. Some of the most important aspects of the law are that it safeguards the community water rights and their equitable shares at head, mid and tail. Moreover, it has the factor of connectivity - keeping communities connected and organised around their limited available resources.

The overview of policies given in this chapter (also see Figure 11.1) indicates that there is no dearth of provincial policies, and that most are in complementarity with the national policy framework. In addition, water appears as a high priority in the province without any major contradiction regarding intent between the various policies. However, effective implementation is extremely challenging. Since the 1980s, KP province has been and remains a flag bearer for integrated resource management through various international and government financed development projects. Operating at different scales and using various tools and approaches, they provide good examples of coordination. It can be hoped, therefore, that collaboration and coordination among different water stakeholders within the province can be achieved in implementing the newly approved IWRM strategy.

- **The Canal and Drainage Act 1873 (Federal & Provincial)**
- **Kulyat and Rewajat 1906 (Spate irrigation system)**
- **The KP Water users' Associations Ordinance 1981 (amended 1987)**
- **The NWFP Rural Area Drinking Water Supply Scheme Act, 1985**
- **The NWFP Irrigation and Drainage Authority Act (1997)**
- **River Protection Ordinance 2001**
- **National Drinking Water Policy 2009 (Federal)**
- **Khyber Pakhtunkhwa Local Government (Amendment) Act, 2015**
- **Khyber Pakhtunkhwa Drinking Water Policy - 2015**
- **Pakistan National Water Policy, 2018**
- **Khyber Pakhtunkhwa IWRM Strategy 2020**
- **Khyber Pakhtunkhwa Water Act 2020**

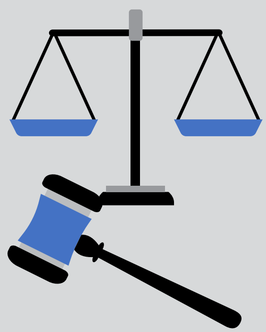


Figure 13.1. Summary of formal water Laws and Policies pertaining to KP province

56 Spate irrigation is an ancient system of water management unique to semi-arid environments, found in the Middle East, North Africa, West Asia, East Africa and parts of Latin America. The essential element of spate is flooding the ground either using natural flood from rains in an upstream macro-catchment or creating a flow to irrigate a larger ground through storing water from seasonal floods of rivers, streams, ponds and lakes. It is a huge management effort to optimize flow of water. A defining characteristic of spate is uncertainty since the number and quantity of floods vary from one year to another depending on dry riverbeds when these are in spate. A rough estimate of spate area globally is 2.0-2.5 million hectares (ha). The largest area under spate irrigation is in Pakistan (1,402,000 ha). (Nizami et al., 2019; Nizami and Khattak 2014; Khan et al., 2014).

57 Spate irrigation is known as *Rudh Kohi* in KP and Punjab, *Sailaba* in Balochistan, and Nai in Sindh (ibid).

58 Bund is a spur or a micro-catchment artificially created through earthen embankments to intercept and store floodwater on a temporary basis to ultimately regulate the irrigation flow to fields.

Chapter 14
Pakistan's water discourse and challenges

School girls in District Malakand

Chapter 14
Pakistan's water discourse and challenges

Arjumand Nizami
Jawad Ali

This concluding chapter brings together a few key questions of common interest raised in earlier chapters related to the water profile and governance. The discussion mostly relates to the national context, which clearly influences the water policies, strategies, and markets of KP province.

As discussed in Chapter 13 on the policy landscape, all the sectors and sub-sectors related to water have their own managers. Various public sector departments have one or more segregated regulatory roles in the water sector. The provinces are empowered to operate within certain Acts, policies, or rules. There is no dearth of policies regarding water and water relevant sectors. This, however, has not solved the problems confronted today by managers and users of water resources. As a water-dependent economy in Pakistan, the greatest problem is water mismanagement and not water scarcity.

The approval of the National Water Policy in 2018 was a much-awaited policy step, embraced by all the actors in Pakistan. Following policy approval, expert and non-expert groups started engaging in discussion on how this policy could be implemented across the country. Three news articles published in 2018 received much attention from authorities including the Supreme Court of Pakistan. These articles used a provocative title, suggesting that Pakistan would run dry by the year 2025 (Gulzar, 2018; Baloch, 2018, Raza, 2018). The result of this provocation was a well-deserved visibility for water sector issues, especially Pakistan's fast declining per capita water availability below 1,000m^3. The issue took further impetus from several specialist discussions in 2018 and in later years. The then Chief Justice of the Supreme Court of Pakistan and the Premier, leaders from all walks of life appeared advocating for the construction of new reservoirs and raising funds for water projects, as if on a war footing. A continuous mass media campaign trickled down to the common citizens and water users, raising their awareness of the need for new reservoirs. This also supported the narrative of organisations promoting the conservation of natural resources including water.

Despite a national policy which promotes integrated approaches to solving the country's water challenges, the discourse on building new reservoirs dominated. The importance of reservoirs is not denied. However, in a country in which the inefficient use and wastage of water is one of the highest in the world, it is more important to first invest in plugging the holes in Pakistan's water bucket (explained in Chapter 6) through improved water governance before enlarging the damaged bucket.

Institutional responsibility for water in Pakistan

The Pakistan National Water Policy, 2018 states that all water-related Acts shall be reviewed for updating (section 27.2). Where appropriate, they shall be integrated through a smaller number of more comprehensive and updated Acts in order to eliminate overlaps. Further, in section 27.3 the policy states that the appropriateness and need of each water-related institution to have a supporting legal cover shall be examined and provided where found necessary to enhance institutional effectiveness. These intentions may require a huge institutional surgery, not mere rearrangement, to ensure that the water sector has a clear duty bearer and that the policies are implemented to their true letter and spirit.

Despite agriculture reportedly consuming 90% of all available freshwater sources, it is not the agriculture sector that enjoys control over water supply and resource development. Rather, it is other departments including WAPDA, IRSA and the Irrigation departments mandated to develop and manage water and power resources of the country. Both WAPDA and IRSA are centralised departments, while the main water user, i.e. the agriculture sector (as well as other users including the domestic and private sectors), is a devolved subject. Reliable data on water demand in the provinces from the rapidly growing domestic and private sectors is not available. The estimates of water demand from the provinces to the main water distribution authority is based on highly estimated numbers that have not changed in decades. It is believed that the large growers and other powerful users have the influence to grab the largest share of the water allocated to the provinces.

Unless water allocation is made subservient to the realistic demand from a decentralised level, e.g. the districts, unrealistic allocations will continue, and water allocations will remain inadequate even if the overall supply is adequate. An additional dimension of water deficiency is caused by water mismanagement and unsustainable water uses through flood irrigation, which is practiced in most parts of the country. In this system water is injected into the canal system. The first 50% is lost into the system. The remaining water is not enough to reach downstream uses. Nearly one third of users gain excess water by illegally widening their outlets upstream and by finding other ways to steal water. Entitlements to water are thus not equitably exercised. Theft is built into the allocation system because some users are greedy and are supported by powerful interests or because there is no choice left for those at the losing end. The canal system is governed by Irrigation departments in the provinces which enjoy considerable authority. Water theft remains a complicated issue for districts to tackle. Although the districts have no authority over canal irrigation water, but water theft matters come to them for resolution.

In conclusion, the institutional responsibility for water in Pakistan is scattered among actors, with clear responsibilities being over-lapping or missing. As the main consumers, farmers are neither recognised as an institution nor are held responsible for sustainable water use.

Water consumed is not produced in Pakistan's agriculture

Nearly every narrative on water in Pakistan, including this book, begins with scary water statistics including the fast-declining annual per capita availability of freshwater in Pakistan – which has dropped from 5,000m^3 at the time of independence to around 1000 m^3 in 2019 and is further declining. Pakistan is a water economy with 80% of the country's exports being virtually water trade and agriculture contributing 19% to the GDP. The official figures quote that over 90% of fresh surface water goes to agriculture, of which more than 50% is wasted before it reaches crops while over 30% of this is lost in the field due to inefficient irrigation practices. Despite a liberal use (or overuse) of water, water productivity in Pakistan is extremely low. Pakistan's problem, therefore, is poor water efficiency and not declining per capita water availability. Below are several examples which challenge the narrative of extremely low per capita availability of water in Pakistan.

Pakistan stands 35th in the world in term of total renewable water resources in cubic kilometres (km^3)[59]. This means that only 34 countries are better endowed than Pakistan out of total 171 countries. The countries located much lower in the ladder include for instance Turkey (41), France (42), Spain (62), Portugal (79), and Israel (153), to name just a few. All these countries are largely dependent on agriculture and livestock and their economies are far healthier than Pakistan's. The same countries are analysed for their per capita access to fresh water: Pakistan as of today stands around 1,000 m^3 per capita when compared to Turkey (549), France (512), Spain (730), Portugal (817), and Israel (282). Thus, lack of water is not a valid reason for the lack of progress in the agricultural economy. An analysis is needed of what is different in other economies that still brings them far ahead of Pakistan despite their relatively limited water resources.

The productivity of water in Pakistan is very low compared to other countries. For example, for cereals it is 0.13 kg/m^3 of water against 1.56 kg/m^3 in USA, 0.82 kg/m^3 in China and 0.39 kg/m^3 in India (Kumar, 2003). For the 38.87 million tonnes of cereal produced in Pakistan, the country uses 249,173 million m^3 of excess water compared with China and 199,338 million m^3 compared with India. This excess water, if saved, could have produced 77 million tonnes of additional cereals - either by increasing the area under irrigation or by improving the water productivity of agricultural crops. Pakistan needs to shift its focus from managing scarcity to managing water efficiency to meet the critical demand in each sector, making use of each drop of water.

Another important perspective is the cropping system prevailing in Pakistan. In effect, water is Pakistan's biggest export since most of the country's exports depend on wa-

59 https://en.wikipedia.org/wiki/List_of_countries_by_total_renewable_water_resources accessed 9th September 2018

ter-intensive crop-based commodities including textiles, leather, rice, and others. This is tantamount to Pakistan subsidising buyers in developed and high-income countries who buy Pakistan's rice, leather goods and textiles without paying for water. This would not be a concern if Pakistan was not primarily an arid or semi-arid country. Pakistan is one of the few countries in the world which is growing rice, sugarcane, and cotton in desert conditions. Export data from the last five years show that these crops dominate Pakistan's export figures (Figure 14.1).

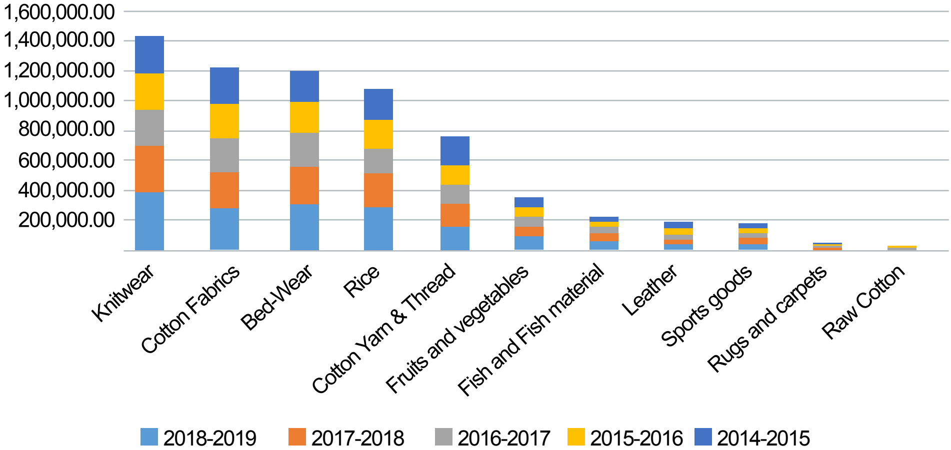


Figure 14.1. Exports by commodity/groups of commodities (million PKR)

Data in Figure 14.1 indicates that cotton and rice are highest on the export data. Rice is one of the highest water-demanding crops and is an important staple in addition to serving as a source of revenue generation through export. Pakistan ranks third among the top ten rice exporting countries in the world. Rice is the third largest crop in terms of the area sown and the second most important economic crop after cotton[60]. Its cultivation engages over 700,000 farm labours including around 200,000[61] who transplant the seedlings (80% of whom are women, the most vulnerable group in the rice value chain). Punjab has 60% of the country's rice area - 4.4 million acres. With the current cultivation practices, Pakistan has the fourth highest rate of water use in the world. This simply means that the amount of water used in m^3 per unit of GDP is the world's fourth highest.

Water-intensive crops have been introduced in out-of-basin regions too. For instance, cotton, rice, and sugarcane have become southern Punjab's and Balochistan's largest agricultural commodities. There has been a massive expansion of land under sugarcane cultivation from 896,100 ha in 1991-92 to 1,128,098,100 ha in 2012-13[62].

60 Pakistan Agriculture Statistics, 2016. Government of Pakistan

61 Data on labourers engaged in transplanting paddy is not available for rice producing districts of Pakistan. The data provided here is based on the number of labourers needed for this task in one district using data collected on individuals engaged/ ha/ season. This has been extrapolated for the rest of the rice producing districts.

62 Pakistan Sugar Mills Association (PSMA) https://www.psmacentre.com/

In order to maintain these exports, it is even more important to switch to highly specialised water efficient techniques in agriculture so that Pakistan continues to earn revenues from these exports.

In addition, further encouraging horticultural and leguminous crops may be highly relevant in the export-competitive domain. Lentils are in high demand in the international market and are ideal for growing in arid and semi-arid subsistent conditions with little attention. Trade liberalisation on lentils may attract several interested buyers from European food companies. What Pakistan needs is to identify specific zones in which crops suited to unique climatic and hydrological conditions with strong economic potential may be grown. This will help to wean farmers away from cultivating water-intensive crops to planting legumes instead and could bring much needed cash to poor farmers in water scarce areas. If incorporated into local diets, legumes can also help address stunting and malnutrition problems since they are high in protein.

The role of the corporate sector in achieving water efficiency

As a significant water user, the corporate sector could play an important role in promoting water efficient agriculture practices. Some examples, although few, are emerging primarily because of the international obligation associated with export commodities. There are a few national and multi-national companies engaged in exporting agricultural commodities that are currently supporting farmers to adopt water efficient techniques.

One such example is in the rice sector where Mars Foods and Rice Partners' Limited (a local company), is supporting paddy farmers to produce rice based on standards approved by the Sustainable Rice Platform (SRP). This initiative, called the Water Productivity (WAPRO) project, is led by HELVETAS Swiss Intercooperation with support through the Swiss Global Programme. Two other private companies Galaxy Rice Mills and Westmill have joined this effort. WAPRO is testing various water efficient techniques including alternate wetting and drying and precision land levelling using laser technology. The results, based on pre and post project, show that tube well water application efficiency improved in the range of 19.4% to 24.3% (see figure 14.2). Net revenue from rice per acre increased in the range of 190% (head), 154% (mid) and 122% (tail). Hence water productivity turned out to be an economic case for the farmers, companies, and the government. More such examples are needed. Similar initiatives are being taken in cotton with an incremental switch to Better Cotton standards.

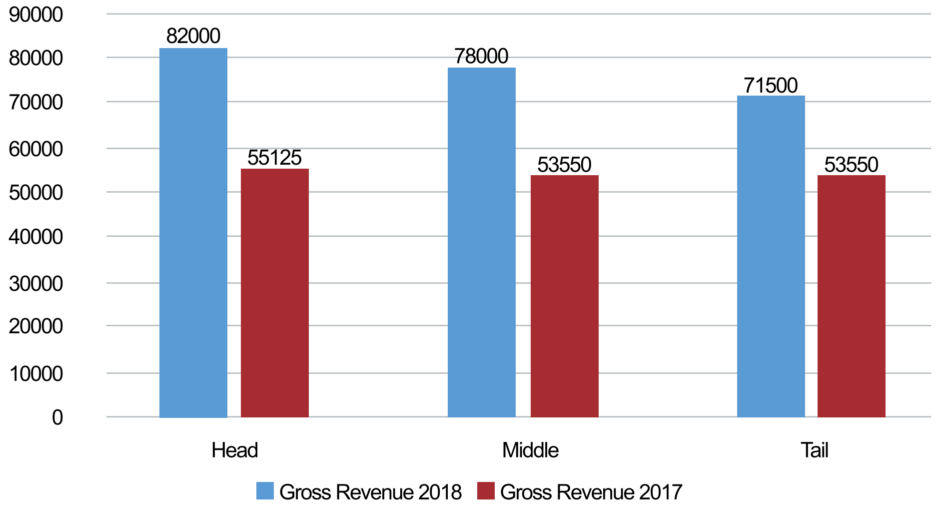


Figure 14.2. Net revenue per acre (PKR) baseline vs current (two seasons)

As export commodities, both rice and cotton are more likely to receive such attention from companies than crops produced for domestic consumption. The challenge lies in the sugarcane and livestock sectors which also consume high quantities of water.

Another example is of bottled water and the beverage industry. So far, these industries have been using and polluting fresh water, especially groundwater, for free. In 2018, the Supreme Court of Pakistan imposed a one-rupee per litre surcharge on commercial water bottlers. However, the order fails to make the corporate sector more responsible because it neither requires companies to abstain from using water resources that are declining nor introduces any cap on the quantity abstracted.

In Pakistan, the role of the private sector in depleting and contaminating water resources was highlighted after the Supreme Court's decision to charge fees on the bottled water industry. In making this ruling, the Supreme Court declared that groundwater is the property of the state. Even before this directive, various government agencies in KP province had started revising water tariffs for piped drinking water to ensure that commercial water users pay more than domestic customers. For example, an agency supplying piped drinking water in parts of the capital city charges PKR 424 per month for domestic uses and PKR 4,830 for service stations and small hotels. Another agency charges a monthly PKR 532 to domestic users compared to PKR 5,844 for gas stations. In both cases, commercial tariffs are more than ten times higher than the domestic rate. It is expected that this system will be extended to other cities where the private sector currently shares free piped water being supplied for domestic uses.

The Supreme Court ruling provides an opportunity for the lawmakers to review the legislation, or rather the lack of it, on groundwater. Companies do not have a legal access to groundwater; they are free riders so far, but this legal loophole needs to be closed.

Who governs domestic water?

Pakistan is characterised by multiple authorities with overlapping responsibilities and duplication of work. As such, in terms of domestic and industrial water supply, the problem is not so much of water availability but the system of water management and governance.

There is no federal water ministry, as WASH is a provincial matter. Provincial governments are responsible for water and sanitation. In the provinces various institutions are involved in water management. The Public Health Engineering Departments (PHEDs) install drinking water supply projects in rural areas and in some cases urban areas. The Tehsil Municipal Authorities (TMAs) are responsible for water and sanitation services in urban areas. In KP, the government has established Water and Sanitation Services Companies (WSSCs) to takeover TMA functions. Other agencies also provide drinking water in parts of the same cities - for example, the Peshawar Development Authority in Peshawar.

Urbanisation and population growth are driving the entire domestic water management system into a virtually unmanageable situation. Competition between different users and sectors contributes to groundwater over-extraction, deteriorating water quality and a significant decline in groundwater levels (Qureshi and Sayed, 2014). Drinking water is often contaminated and institutions cannot afford to conduct water quality tests (Lerebours, 2017; Lerebours and Villeminot, 2017).

Improving monitoring and evaluation, capacity building of duty bearers, installing water meters for monitoring and billing domestic consumption, proper waste and wastewater management and regulation including building treatment plants and raising awareness of water conservation are a few of the measures that can change the situation.

Water pricing in Pakistan

Water pricing may be a key to rationalise consumption, serving as a game changer. Water pricing can steer a revolution from a supply driven system to one in which accountability is in-built, and over-exploitation by elites is checked. Simple technology can make this possible, provided there is a will. A water-saving and pricing formula needs to be agreed among the federating units that will reduce the share of water use for agriculture from 90% to the global average of about 70%[63] so that more water is available for domestic and economic uses.

63 20% global water is accounted for businesses and 10% for domestic use.
https://www.worldometers.info/water/ accessed on 12th November 2019.

Introducing volumetric water pricing is more political than technical. Any kind of reform on water pricing, as intended by the National Water Policy, 2018, needs to be time-bound and very clearly laid out in a stepped manner.

The pricing system must aim at recovering a 100% cost of water management including operation and maintenance of the system to ensure efficiency. Water pricing would also mean that the water management and supply institutions will be accountable to service receivers.

Improving data management capacity in the water sector

As stated in Chapter 6, computing the water balance for KP was a daunting task in the absence of accurate source data. However, the experience from KP in preparing the status reports of various water related sectors as background for the Integrated Water Resource Management strategy suggested that there is a wealth of secondary data scattered in various places. An organised precision system will capitalise on this wealth of resources, identify gaps, and make the process of monitoring and securing resources much easier.

Managing water resources effectively requires appropriate information on the resource and related areas. Despite the availability of various scientific methods in the country, attempts to regularly collect and analyse data on a scientific basis and to gain province-wide knowledge are still piecemeal. Quality-assured information comes from a myriad of actors covering domestic and commercial users, resource managers and operators, regulators, and policy makers.

It is important that all the components of the hydrological cycle are considered when developing provincial or local water management plans. For this purpose, knowledge of the entire hydrological cycle, including total availability of water, water quantity and quality of various sources (surface and ground), is imperative. The province does not have enough systematic data on these parameters. Water managers have so far struggled to put in place adequate water information systems in the province. The Integrated Water Resource Management strategy of KP attempts to address various challenges related to water informatics in order to improve water management in the province. At the same time, promoting water awareness and knowledge in a non-technical manner amongst common citizens is important for acquiring their goodwill and support in the efficient use of water and the effective implementation of the strategy.

Including in this book, the most quoted figure of water consumption by agriculture is 90% of the country's fresh-water resources. This does not acknowledge the increasing per capita water usage in urban areas in tandem with population growth and the consumption of water by the industrial sector. Due to the lack of volumetric water pricing and monitoring, water consumption in domestic and industrial sectors is not fully known.

Much domestic water consumption in urban areas is unregulated. There are reports of numerous unlicensed water-suction pumps and supply lines being installed in urban and sub-urban areas that break into the system. Abstraction of groundwater is, therefore, not fully unaccounted. The abstraction of groundwater to feed crops and the industrial sector has also grown exponentially but as indicated in Chapter 6, groundwater extraction remains unregulated.

An immense effort is needed to generate data on water use and organise this in a management information system. Such data must be housed in a highly accessible department so that all other departments concerned with water, and research institutions (including students and universities), may benefit.

To conclude this book, there is an urgent need for the water resources in KP province, and indeed Pakistan as a whole, to be managed in a more efficient, effective and above all, more just and participatory manner that ensures access to water for all citizens. This is what the integrated water resource management (IWRM) strategy of KP seeks to do.

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Water PROFILE OF KHYBER PAKHTUNKHWA

Resources, Uses, Governance, Challenges

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