World Bank Group

PAKISTAN@100 ENVIRONMENTAL SUSTAINABILITY

Policy Note
March 2019

TABLE OF CONTENTS

Executive Summary 1

Introduction 11

Chapter 1: Toward Healthy Cities and Productive Citizens 12

1.1 Poor and Deteriorating Air Quality: The Top Public Health Concern 13
1.2 Pakistan's Water: Deteriorating Quality and Poor Service Delivery 19
1.3 Lessons Learned from Past Reforms 23
1.4 Key Policy Choices 25

Chapter 2: Managing Land and Water Sustainably: The Agriculture-Water Nexus 36

2.1 Current Challenges to the Agriculture Sector 36
2.2 Trends for Agriculture Production and Water Demand 44
2.3 Policy and Institutional Reforms 49

Chapter 3: Building Resilience to Natural Disasters 60

3.1 The Heavy Toll of Extreme Weather Events, Particularly Floods 60
3.2 Climate Change Will Affect the Frequency and Intensity of Natural Hazards 62
3.3 Current Government Initiatives on DRM 63
3.4 Toward Enhancing Resilience to Disasters 69

References 74

LIST OF FIGURES

Figure 1. Mean Annual Exposure to Air Pollution in South Asia, Measured as Exposure to PM 2.5 12
Figure 2. Estimated Mean PM 2.5 Concentrations in Pakistan's Cities, 2000-15 14
Figure 3. Age-Standardized Deaths per 100,000 Attributable to Air Pollution, 1990 To 2015 15
Figure 4. Ambient PM 2.5 Death Rate Versus Income 16
Figure 5. CO_2 Emissions (Kg per 2010 US$ Of GDP), 1990 To 2014 18
Figure 6. Access to Water and Sanitation 19
Figure 7. Access to Piped Water on Premises, By Urban and Rural, Selected Countries 20
Figure 8. Access to Improved Sanitation, By Wealth Level, Selected Countries 20
Figure 9. Total WASH Expenditure as Percentage of GDP and Per Capita in 25 Countries 22
Figure 10. Annual Growth in Total Agricultural Factor Productivity (Average Annual Growth Rate per Decade, In Percent) 38
Figure 11. The 2030 Flood Risk in Pakistan 62
Figure 12. Layered Approach for Financial Protection 71

LIST OF TABLES

Table 1. Key Policy Choices 34
Table 2. Water Demand Scenarios for Pakistan 44
Table 3. Key Choices for Managing Land and Water Sustainably 58
Table 4. NDMP Interventions 64
Table 5. Key Choices for Building Resilience to Disasters 73

LIST OF BOXES

Box 1. A Target to Emulate: The Case of China 26
Box 2. Deepening the Devolution: The Case of Punjab 27
Box 3. Forests, a Green Investment to Address Environmental Health and Beyond 28
Box 4. The Role of Cities in Airsheds 29
Box 5. Pakistan Needs to Make Industries Greener and Green Financing is Part of the Scheme 30
Box 6. Financing for Green Growth 32
Box 7. The China-Pakistan Economic Corridor (CPEC) 33
Box 8. Low Availability of Certified Seeds in Pakistan 40
Box 9. The Cost of The Wheat Market in Pakistan 42
Box 10. No Significant Change in River Flow Projected Before 2050 45
Box 11. Climate Change: Where Is Pakistan Heading? 47
Box 12. Interprovincial Disputes Continue to Dominate the Policy Debate on Water Reforms 50
Box 13. Leading By Example: Agriculture Reform In Punjab 53
Box 14. Possible Wheat Sector Reforms 55
Box 15. Expanding Access to Crop and Livestock Insurance in Punjab 57
Box 16. Pakistan: A Two-Phase Window To Balance Urgency With Targeting 65

ACKNOWLEDGEMENTS

This policy note has been prepared by a World Bank team led by Philippe Ambrosi (Senior Environmental Economist) and Marcelo Acerbi (Senior Environmental Specialist) with technical inputs from William Young (Lead Water Specialist), Johannes (Hans) Jansen (Senior Agriculture Economist), Ahsan Tehsin (Disaster Risk Management Specialist), Anna Gueorguieva (Senior Economist, Environmental Health Section), Bianca Moldovean (Consultant, Environmental Health Section), Syed Muhammad Bilal Khalid(Disaster Risk Management Analyst), Yoonyoung Cho (Senior Economist), Hyunjee Oh (Disaster Risk Management and Climate Change Specialist), Chandra Shekhar Sinha (Lead Climate Change Specialist), and Rajesh Koirala (Natural Resources Management Specialist). The team was supported by Rahat Jabeen (Environmental Specialist), Abdul Qadir (Senior Program Assistant), Radhika Goyal (Consultant), and the Sustainable Development Policy Institute (SDPI). The note was prepared under the guidance and advice of Kseniya Lvovsky (Practice Manager, GEN06), Michael Haney (Practice Manager, GWA06), Christoph Pusch (Practice Manager, GSU18), Loraine Ronchi (Practice Manager, GFA06), Urvashi Narain (Lead Economist), and Enrique Blanco Armas (Lead Country Economist). Peer reviewers for this policy note were Tijen Arin (Senior Environmental Economist, GEN06), Stephane Hallegatte (Lead Economist, GFDDR), IJsbrand de Jong (Lead Water Resource Management Specialist, GWA06), Helena Naber (Senior Environmental Specialist, GEN05), and Helen O'Connor (Team Leader, Conflict, Humanitarian and Resilience Team, and Senior Climate and Environment Adviser, DFID Pakistan).

This policy note builds on a desk review of analytical work and project documentation, as well as interviews with task teams, technical experts in line ministries in Pakistan, development partners, and civil society representatives active on environmental sustainability in the country. These interviews helped deepen the understanding of the development challenges and sustainability in key sectors, capture specific experiences, and identify gaps and the need for reforms. The contribution of the institutions and experts listed below is gratefully acknowledged. All errors and omissions remain the sole responsibility of the authors.

- The National Disaster Management Authority (NDMA), the Global Change Impact Studies Centre (GCISC), the Environmental Protection Agency (Pak-EPA), the Ministry of Climate Change, the Water Resources Ministry, the Agriculture Ministry, the Planning and Development Commission, and the National Ministry of Food Security and Research.
- The World Health Organization (WHO), the UK Department for International Development (DFID), the United Nations Development Programme (UNDP), AFD, the Australian High Commission, the United States Agency for International Development (USAID), the Asian Development Bank, Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ), the Food and Agriculture Organization (FAO), and the International Food Policy Research Institute (IPFRI).
- The Pakistan Council of Research in Water Resources (PCRWR), the International Union for Conservation of Nature (IUCN) Pakistan, and the World Wide Fund for Nature (WWF) Pakistan.

- World Bank staff: Muhammad Waheed (Senior Country Economist); Mohammad Farhanullah Sami (Senior Water Supply and Sanitation Specialist); Haris Khan (Senior Disaster Risk Management Specialist); and Ahsan Tehsin (Disaster Risk Management Specialist).

The following institutions kindly provided inputs on institutional and policy reforms during a focus group discussion held on February 26, 2018, in Islamabad and led by SDPI: the P&D Department (Government of GB), the P&D Department (Government of Khyber Pakhtunkwa), the Pakistan Agricultural Research Council (PARC) (Islamabad), the Global Change Impact Studies Centre, EPA (Balochistan), EPA (Peshawar), the Forest Department, Azar Jammu and Kashmir (AJK), EPA (Sindh), NDMA, and the Ministry of Climate Change.

An earlier draft of this policy note was discussed during a two-day event at Lahore University of Management Sciences in March 2018. Comments were received from the following experts:

- Kulsum Ahmed (Former Practice Manager, Environment and Natural Resources Global Practice, World Bank);
- Tariq Banuri (Director, Future Sustainability Programme of Stockholm Environment Institute; Professor at University of Utah);
- Aisha Khan (Chief Executive Officer, Mountain and Glacier Protection Organization); and
- Sanval Nasim (Assistant Professor of Economics, Lahore University of Management Sciences).

GLOSSARY

ADP	Annual Development Plan
AIS	Agriculture Innovation System
AQI	Air Quality Index
AQM	Air Quality Management
BIPP	Burki Institute of Public Policy
BISP	Benazir Income Support Program
BTTAP	Billion Tree Tsunami Afforestation Project
CBDRM	Community-Based Disaster Risk Management
CCKP	Climate Change Knowledge Portal
CDCP	Citizens Damage Compensation Program
CIS	Climate Information Services
CLIS	Crop Loan Insurance Scheme
CPEC	China Pakistan Economic Corridor
DALY	Disability-Adjusted Life Year
DRF	Disaster Risk Financing
DDMA	Disasters Management Authority
DRM	Disaster Risk Management
DRR	Disaster Reduction and Recovery
EPA	Environmental Protection Agency
EPD	Environmental Protection Department
EPI	Environmental Performance Index
ERRA	Earthquake Reconstruction and Rehabilitation Authority
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
EWS	Early Warning System
FATA	Federal Administrated Tribal Areas
FDRA	Fiscal Disaster Risk Assessment
FDRAP	Federal Disaster Response Action Plan
GCISC	Global Change Impact Studies Centre
GDP	Gross Domestic Product
GFDRR	Global Facility for Disaster Reduction and Recovery
GHG	Greenhouse Gas
GLAAS	Global Analysis and Assessment of Sanitation and Drinking Water
GLOF	Glacial Lake Outburst Flooding
IBIS	Indus Basin Irrigation System
IMF	International Monetary Fund
INDC	Intended Nationally Determined Contributions
IRSA	Indus River System Authority
IUCN	International Union for Conservation of Nature
JICA	Japanese International Cooperation Agency
KP	Khyber Pakhtunkhwa

M&R	Maintenance and Repair
MHVRA	Multi-hazard and Vulnerability Risk Assessment
MOWP	Ministry of Water and Power
MTDF	Mid-Term Development Framework
NADRA	National Database Registration Authority
NDC	Nationally Determined Contribution
NDM	National Disaster Management
NDM ACT	National Disaster Management Act
NDMA	National Disaster Management Authority
NDMC	National Disaster Management Commission
NDMP	National Disaster Management Plan
NDRMF	National Disaster Risk Management Fund
NEQS	National Environmental Quality Standards
NFC	National Finance Commission
NFPP	National Flood Protection Plan
NRE	New and Renewable Energy
NOX	nitrogen oxide
NSER	National Socio-Economic Registry
PAMRA	Punjab Agricultural Marketing Regulatory Authority
PAPMO	Punjab Agricultural Produce Markets Ordinance
PARB	Punjab Agriculture Research Board
PARC	Pakistan Agricultural Research Council
PASSCO	Pakistan Agricultural Storage and Services Corporation
PCRWR	Pakistan Council of Research in Water Resources
PDMA	Provincial Disaster Management Authority
PEPA	Pakistan Environmental Protection Act
PEPC	Pakistan Environmental Protection Council
PHB	Punjab Horticulture Board
PM	Particulate Matter
PMD	Pakistan Meteorological Department
PPP	Public-Private Partnership
P&D	Planning and Development Department
R&D	Research and Development
RCP	Representative Concentration Pathway
RECP	Resource Efficient and Clean Production
SDPI	Sustainable Development Policy Institute
SECP	Securities Exchange Commission of Pakistan
SMART	Strengthening Markets for Agriculture and Rural Transformation
SME	Small and Medium Enterprise
SPEI	Standardized Precipitation Evapotranspiration Index
TFP	Total Factor Productivity
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme

UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
USAR	Urban Search and Rescue
WAPDA	Water and Power Development Authority
WASH	Water Supply, Sanitation, and Hygiene
WCFC	Watan Card Facilitation Center
WHO	World Health Organization
WQM	Water Quality Management
WSTF	Water Sector Task Force of the Friends of Democratic Pakistan
WWF	World Wide Fund for Nature

EXECUTIVE SUMMARY

Challenges toward Sustainable Growth in Pakistan

Growth in Pakistan has come with high environmental costs. Environmental degradation is slowing down growth and reducing the quality of life. Industrial pollution combined with pollution from urban areas are creating an immediate threat to health, quality of life, and economic productivity. The spectrum of environmental issues encompasses poor air and water quality, as well as natural resource degradation (such as over-extraction of water, deforestation, and land degradation, or biodiversity loss). Climate change further exacerbates the pressures, while environmental pollution and degradation is often associated with increases in greenhouse gas (GHG) emissions.

As Pakistan has grown and urbanized rapidly, the patterns of environmental degradation have increasingly shifted and expanded, with the impacts coming to represent a significant and growing cost in the range of 2.5 to 6.5 percent of gross domestic product (GDP) equivalent. Pakistan has been urbanizing rapidly and it is estimated that about 50 percent of the population will be living in urban areas by 2030. This has translated into Pakistan being ranked as one of the countries with the highest levels of exposure to air pollution in the South Asia region, measured as mean annual exposure to fine particulate matter (PM 2.5). The problem is amplified in the cities—the engines of Pakistan's growth—with urban agglomerations such as Lahore reaching levels of PM 2.5 in the range of 2 to 14 times higher than the World Health Organization (WHO) guidelines.

Concurrently, with regard to water quality, 69 percent of water sources do not meet the national standards for drinking water. Industrial and agricultural effluents are also a major concern. With regard to the impact on Pakistan's GDP, in 2016, the annual cost of air pollution in Pakistan was estimated to be between 2.5 and 6.5 percent of GDP equivalent (Strukova, 2018). The 2016 annual cost of inadequate water supply, sanitation, and hygiene (WASH) was estimated to be 0.9 percent of GDP equivalent in urban areas and 1.8 percent of GDP equivalent in rural areas (Hutton and Varughese, 2016). In addition, inequality in access to WASH correlates closely with income levels and varies significantly across regions. In the 'business-as-usual' scenario, given that Pakistan currently has a higher number of deaths due to air pollution per 100,000 than China, the country is likely to see a detrimental increase in public health costs, with a disproportional impact on the poor in urban centers.

Agriculture is by far the largest user of water in Pakistan—at more than 90 percent of withdrawals. It is the single largest employer in the country (just above 40 percent of the labor force) and the top source of export revenue (more than 80 percent). While this partly reflects a transition toward a more highly skilled, modern, and productive economy (albeit at an uneven and slow pace), agriculture is characterized by an inefficient crop mix and overuse of resources, such as water. Its productivity is below global and regional levels due to low farm-level productivity, price distortions, and the unsustainable use of natural resources, particularly water.

Water productivity in Pakistan is very low; reform, investment, and modernization are required to greatly improve performance and transform irrigation into a vibrant commercial enterprise. The current water-use in agriculture (for irrigation) is technically inefficient due to poorly maintained and operated infrastructure, and widespread use of water-wasteful irrigation methods. Water use is also economically inefficient due to distorted policy incentives that encourage water-thirsty crops (especially sugarcane and rice, but also wheat and cotton) at the expense of less water consuming crops with higher value-added (such as horticulture, oilseeds, and pulses) for which consumer demand is growing. Inadequate and deteriorating drainage infrastructure means that waterlogging and salinity are widespread and worsening. The overall result is low economic productivity of water in agriculture (only 12 countries rank lower). A reduction of the share of agriculture in the total water demand requires a comprehensive approach toward simultaneous transformation in the agriculture and water sectors through the introduction of a series of policy reforms and institutional changes, the development of an enabling legal framework, and targeted public investments in irrigation infrastructure rehabilitation and improved water governance. Such an approach has thus far been lacking in Pakistan.

Climate change compounds environmental and development challenges. Changing climate already manifests itself with rising temperatures and more prevalent heatwaves, melting in the cryosphere, and increased risk of Glacial Lake Outburst Flooding (GLOF) in the mountainous regions, as well as rising sea level resulting in accelerated costal erosion and salination of groundwater. Meanwhile, extreme weather events have grown in severity, with high human and economic costs. Climate change will intensify over the coming decades, making water resources less predictable with more erratic patterns and extremes on the rise, such as heatwaves, droughts, and floods. In addition, sea level rise and saline intrusion will continue to threaten coastal infrastructure, agricultural lands, and aquifers in Karachi and the adjoining Indus deltaic region. Climate out-migration is expected to occur from coastal areas because of sea level rise and storm surges.

A key dimension of vulnerability in Pakistan is exposure to hydrological and meteorological (hydromet) hazards, including storms, floods and droughts. Pakistan is ranked seventh on the Global Climate Risk Index and extreme weather events are expected to grow in severity, with high human and economic costs. Studies and assessments by the Pakistan NDMA conclude that climate-related disasters resulted in an average economic loss of US$3.99 billion per year over 1994 to 2013 (MoCC, 2016). On average, 3 million people are affected by natural catastrophes every year, with floods being the dominant hazard (77 percent population affected), followed by droughts (14 percent) and earthquakes (4 percent).

The annual economic impact of flooding is estimated to be between US$1.2 billion and US$1.8 billion, equivalent to between 0.5 percent and 0.8 percent of national GDP. Simulations show that a major flood event (occurring, on average, once every 100 years) could cause losses in excess of US$15.5 billion, which equates to around 7 percent of national GDP, equivalent to almost 40 percent of the federal budget (World Bank and GFDRR, 2015). Two-thirds of the populations affected historically are located in Punjab and 20 percent in Sindh (World Bank and GFDRR, 2015). While the financial impact of natural disasters in Pakistan – i.e., the damage inflicted on buildings,

infrastructure, and agricultural production – is estimated at around 0.6 percent of GDP every year, their overall incidence on well-being is estimated to be much larger, at about 0.9 percent of GDP equivalent, given the prevalence of poverty. In relative terms, poorer people suffer much more than wealthier people: they tend to be overexposed to disasters; they suffer from higher relative losses to their assets and livelihoods; and bear a greater toll in terms of impacts on saving and investment behavior (Hallegatte et al., 2017).

At the root of the problem is the inability of current policies and institutions to foster sustained environmental improvements, without significant reforms. The 18th Constitutional Amendment passed by the National Assembly on April 8, 2010, enhanced provincial autonomy and reshaped federal-provincial relations. A total of 43 departments in 18 ministries were abolished in 2011/12 and transferred to the provinces. In parallel, a new resource redistribution formula under the 7th National Finance Commission (NFC) Award of 2010 shifted greater funding to the provinces. The provinces' taxing powers were expanded, including a sales tax on services, while internal and external borrowing by provinces was also permitted. Pakistan has developed a set of environmental policies and regulations for environmental management and pollution control at the national and subnational levels, but there is a pressing need for provinces to act on policies and regulations, address significant implementation issues, and increase the weak institutional capacity of enforcement agencies and other key players. The 'new institutions' (Environmental Protection Agencies [EPAs]) need support and restructuring if they are to take a leading role in this decentralized management scenario.

Several institutional, financial, and capacity issues have undermined the success of past environmental reforms in Pakistan. Environmental planning and monitoring could not be sustained and without this key function, in the hands of weak environmental institutions, environmental problems such as pollution could not be managed against existing or new standards. A lack of accountability and transparency in the different levels involved with environmental management and a lack of citizen engagement, public consultations, and disclosure have also served to undermine improvements in enforcement. Complex environmental pollution problems are still being managed using an old-fashioned approach, without considering the scope of airsheds and watersheds. The failure of past reforms has also been underpinned by the lack of interjurisdictional and intersectoral coordination. Finally, the phenomenon of 'elite capture' has contributed to restricting systemic changes in environmental institutions, and reducing compliance with the regulations and behavioral changes by polluters.

The Government of Pakistan (GoP) has taken legal, institutional, and policy measures for Disaster Risk Management (DRM) but many challenges remain, such as securing access to financial resources before a disaster strikes. The National Disaster Management (NDM) Act was passed in 2010, under which a National Disaster Management Commission (NDMC), headed by the Prime Minister, and Disaster Management Authorities were established at the national and provincial/regional levels. Following the passage of the 18th Constitutional Amendment in 2010, Provincial Disaster Management Authorities (PDMAs) have assumed an enlarged mandate and greater implementation responsibility to prepare for and respond to disasters. The National Disaster

Risk Reduction Policy (2013) was developed as an overarching policy document that should be translated across the provinces. However, many entities still have overlapping mandates, and capacities across provinces vary considerably. In addition, the multisectoral nature of DRM creates complexity regarding ownership and implementation. The heavily decentralized approach to DRM in the provinces is a key contributor to these challenges.

The significant impact of these environmental costs and climate risks on growth, assets, and well-being means that they are now center-stage in public debate. There is now strong awareness among the population about these risks as evidenced by the findings from a poll conducted in 2017 by Gallup and Gilani Pakistan. This shows that 79 percent of Pakistanis cite water pollution as a critical problem (very or somewhat) in their locality, while 74 percent cite air quality (Gallup Pakistan, 2017). Similarly, concerns on climate risks have been growing within the population: in 2015, only one-third of the population believed it was necessary to act immediately against climate change (Gallup Pakistan, 2015), while two years later, in 2017, half the population declared itself concerned about climate change (Gallup Pakistan, 2015). Echoing these concerns, Pakistan Vision 2025 recognizes the necessity of addressing these mounting climate change risks and reversing environmental degradation for sustainable growth if the country is to reach its aspirational target of becoming a high-income economy within the next 30 years.

Pakistan has a choice now to become an example of economic success by 2047 by growing smart, but the window of opportunity is closing fast with the risk of missed opportunities. To change the path of growth, Pakistan needs to go through a broad range of structural reforms (governance and institutions, structural transformation, competition policy, infrastructure, and so on) that leads to efficiency gains and a reduction in transaction costs**.** Pakistan needs to grow, but growth needs to be clean, resource efficient, and climate resilient. This transition has costs and it is crucial to implement it to improve systems without creating social issues and instability.

Toward Clean Growth

In the context of growing urbanization, and to achieve healthy cities and productive citizens, Pakistan could focus on the following key policy choices in the short term that could be deepened in the medium and long term with a set of additional policy and institutional measures:

- **Significantly improving the EPAs' and local governments' environmental monitoring capacity in a coordinated manner among the provinces and the federal government.** A country cannot manage what cannot be measured and improving monitoring is crucial. Environmental data that confirm high pollution levels in Pakistan come from global datasets and some limited data come from the country. Pakistan needs to improve environmental monitoring in general, which is currently weak and lacks granularity. A key mandate of EPAs, as part of their core functions, is environmental monitoring. The first step is to understand current pollution levels and sources by rebuilding the monitoring network, not only with equipment but also its protocols; analytical capacity; and technical, institutional, and financial sustainability. To plan an effective pollution reduction action plan, the authorities need to

better understand the current pollution levels, concentration, trends, and sources. Monitoring is instrumental for planning, implementation, and evaluation of progress made. Action plans to address pollution cannot be implanted without these basic monitoring features. Realistic standards can neither be set nor enforced, without knowing the levels of pollution with more granularity.

- **Deepening the devolution by completing the reform of the environmental decentralization, distinguishing between and revising federal, provincial, and local roles and responsibilities, and which policy actions need to be taken by whom and how to coordinate it all, given boundary and efficiency issues.** There is an opportunity to make devolution work for a better environment in Pakistan. This could start by focusing on the institutions with a core environmental mandate such as the provincial EPAs. These entities have pressing needs of institutional strengthening, capacity building and reform. Reforms could consider areas such as: (i) restructuring and capacity building, including air quality management (AQM)/water quality management (WQM) planning with appropriate labs and models, along with the protocols and technical/financial capacity to maintain them; (ii) regulatory reform; and (iii) information disclosure and citizen engagement. Provincial environmental entities can also play a key role beyond enforcement and can contribute to the development space by improving their capacity to: (i) promote green financing, mainstreaming green investments in the public sector; and (ii) support the adoption of Resource Efficient and Clean Production (RECP) measures in polluting sectors. In addition, the role of local governments needs to be clarified and optimized as they play an important role in the provision of environmental infrastructure and services, such as solid waste management, local transportation, or water and sanitation. The existing architecture to support environmental activities at the subnational level needs to be optimized between Environmental Protection Departments (EPDs) and other departments as part of effective coordination and consensus building: subnational multisector strategies, such as the Government Mid-Term Development Frameworks (MTDFs), should integrate environmental activities in sectors such as industry, energy, urban development, transport, irrigation, water, and sanitation.

- **Coordinating for better environmental management among the federal, provincial, and local levels, and among sectors.** The environment is everyone's business and so the coordination mechanism needs to be effective and well-articulated. Air and water pollution are the result of multiple interventions and causes. The role of Pak-EPA or the role of provincial EPAs that were originally designed to focus mainly on large point sources is not enough to manage these problems. Air quality, for example, is not only about regulating industry, energy, and vehicles. It is also about investment in public transport, street and construction dust control (managed by local governments), waste management (managed by local governments), and fuels/stoves used by households and small establishments, as well as agricultural emissions. Even with provincial EPDs/EPAs strengthened, Pakistan is yet to develop the institutional coordination arrangements to manage the environmental challenges such as air quality or water quality at the airshed and watershed levels. In the

meantime, it is important to implement the most conspicuous 'no-regret' actions until the mechanisms are put in place. Better institutional coordination is necessary between the federal and provincial levels. The central level could improve coordination of policy-making and implementation. This means that, in addition to formulating national policies to drive sustainable development, the federal government could provide strategic guidance to the provinces and link provincial-level initiatives to a broader national vision to avoid fragmentation. Coordination becomes an important tool in the context of devolution and decentralization of environmental management.

- **Incentivizing greener investments.** When identifying growth opportunities for Pakistan, the poor state of the environment and looming climate change can also be turned into an opportunity for Pakistan's growth too. Pakistan needs massive and increased investments for growth and hence 'greening' investments are critical. The only way to reconcile investments with sustainability and avoid excessive social/health costs is to make them 'greener' from the beginning. For this, stronger regulation, enforcement, and EPAs are necessary, but these alone are not enough (and growth may even be stalled if these are not combined with other approaches). Regulatory approaches must be complemented by incentives, economic tools, fiscal policies, and financing. Pakistan needs a tax reform for higher investment, which represents an opportunity to design a greener tax regime that includes, for example, pro-growth, pro-poor environmental and carbon taxes, and the elimination of environment damaging subsidies (removal of subsidies for fuels consumed by motor vehicles and industries).[1] Pakistan also needs to have a better financing regime for industries and small and medium enterprises (SMEs) in particular. This is an opportunity to develop green financing that makes access easier for environmentally responsible enterprises/activities.

- **Harnessing the power of public pressure.** Harnessing the power of public pressure by access to environmental data is a key measure to be achieved though: (i) the disclosure of pollution data to engage citizens and encourage preventive actions; (ii) effectively engaging with local communities and relevant stakeholders in the city development planning processes; and (iii) education and raising awareness to empower citizens. Pakistan could strengthen EPDs' capacity to disclose environment information and engage citizens in environmental management through: (i) the timely disclosure of environmental monitoring data online and through other channels (such as TV, newspapers, and radio) in both English and Urdu; (ii) the annual public consultation on and publication of a report on the state of the environment in both English and Urdu; (iii) the strengthening of existing citizen feedback and grievance redress schemes (for example, telephone hotlines and an interactive Internet portal); and (iv) awareness campaigns on pollution management and green development. Education and raising awareness on the value of the environment and its function in an urban setting is critical for effective citizen engagement. It is important to make urban communities, including school children, more aware of the value of natural resources, including wetlands

[1] It is important that the introduction of GHG taxes should be preceded by studies that assess the distributional impacts of these measures, ensure thorough consultation and communication with stakeholders of policy steps, and propose mechanisms to mitigate any regressive effects.

and their functions in urban settings and stress the importance of protecting and managing them. To this end, EPDs should organize activities, such as developing and disseminating various educational materials on the environment and management, and information on what citizens can do.

Toward Resource-Efficient Growth

Managing land and water sustainably to improve, among other things, resource-efficient growth could be achieved by the following key policy choices around three areas of reform: (i) water saving and efficient use; (ii) land productivity; and (iii) climate-smart agriculture.

- **Modernizing water measurement and accounting is imperative to know how much water there is, where it is, how it is being shared, and how it is being used.** This would provide much-needed evidence on the actual status of the irrigation system, helping to identify hotspots for priority action and assess the benefits of interventions (for example, the impact from canal rehabilitation on conveyance losses, the impact from support measures for high efficiency irrigation systems, the impact from reformed water tariffs, just-in-time information on crop water requirements, and so on). This would also help to develop better understanding of demand (including from other sectors, beyond agriculture) in order to shift the culture of water management from a supply-constrained focus to a dynamic demand and supply focus, as well as improve trust and ensure equity between provinces and among farmers (and other water users). Beyond surface water bodies, it is necessary to expand monitoring to groundwater. In addition to investments for extending and modernizing the water measurement infrastructure (including data management and sharing), it will also be necessary to strengthen the mandate for water measurement and water accounting across the Indus River Basin.

- **Effective water tariffs (including more even and effective collection) would contribute to mobilizing sufficient funds.** Ending the so-called 'build/neglect/rebuild' cycle and enabling consistent investment in an otherwise ageing water infrastructure, will improve its technical efficiency (for example, canal lining to reduce conveyance loss), its responsiveness (for example, automation and monitoring for faster and more timely management), and its resilience to growing water variability (for example, increasing storage to cope with flood and drought episodes and accommodate inter-seasonal variability, better matching summer excess and winter demand). Beyond a service fee, which cover the costs of providing the irrigation service, there could be consumptive use charges to incentivize judicious water use, loss reduction, conservation, and the more efficient use of water in agricultural systems, including through the adoption of water-efficient technologies and practices to achieve 'more crop per drop' (for example, drip irrigation, land leveling); or increase water conservation (for example, rain harvesting, no-tillage, or the use of crop residue such as mulch to conserve soil moisture); or shift to crops that are less water-intensive and more drought-tolerant. In the longer term, the introduction of volumetric water-pricing could be considered provided

infrastructure is in place for usage metering and delivery control (e.g., where farmers can "order" the water they need and only take the water they want).

- **Land productivity. This area of reform proposes a more productive and resilient agricultural sector that relates to land productivity, particularly agricultural subsidies and market policies.** Such interventions have a number of side effects: they incur a high fiscal cost and welfare burden, while public resources could be allocated to other uses and social concerns could be addressed by other, more targeted, interventions; they distort cropping decisions, resulting in excess production of some crops and not providing incentives for investing in high-value agriculture and post-harvest value addition; and they promote excessive or imbalanced input use (for example, water or fertilizers), with negative externalities and implications for sustainability. While these policies serve vested interests making their reform politically sensitive (good examples include the public wheat procurement program, electricity subsidies for tube wells, marketing of crops through archaic mandis, low *abiana* rates, and so on), they keep the sector locked in a high-cost/low-return production pattern that results in low incomes for farmers and high prices for consumers. There are options to reform the wheat market, phasing out the public procurement program with accompanying measures such as safety nets and (reduced) emergency stocks. Their implementation is expected to result in significant fiscal savings (lower burden on public purse) and social benefits (through lower price to consumers). Second, liberalizing agricultural markets, and the marketing of crops and livestock products in Pakistan is in urgent need of modernization. For livestock products, occasional price caps have little effect on prices paid by consumers and discontinuing notification of meat and milk prices would to stimulate production and the marketing of larger quantities of better quality and safer livestock products, thus raising the incomes of livestock farmers, while enhancing supplies to urban areas.

- **Climate-smart agriculture. This area of reforms relates to facilitating the transition to climate-smart agriculture, by developing instruments for risk mitigation and supporting research and development (R&D) for diversified and climate-resilient agricultural production**. A risk management system would help safeguard farmers from the increasing risk of crop failure due to climate change. Such a system would include the following elements: climate information services (CISs) (for early warning systems or the development of (parametric) insurance schemes); food security safety net systems (such as cash-for-work and/or food-for-work programs, which could include public work activities to strengthen resilience); and capacity building (which will require particular coordination efforts among agriculture and disasters authorities, at the federal and provincial levels). There is also a need to invest in R&D so that both land and water productivity can be improved, with water-use efficiency and improved seed varieties. In Pakistan, there is a lack of strategy and direction in setting research priorities; cooperation across provinces, internationally, and with the private sector; and managing and incentivizing staff. Increasing public support to agricultural R&D from the abysmal 0.18 percent of agricultural GDP should be a priority. To facilitate the transition to more productive and sustainable, climate-resilient

agricultural production systems, it is necessary to: invest in better agricultural policy and economic analysis (for example, to better understand the scope for different value chains or assess options to reform subsidies); better reasearch and development (for example, to support development of cultivars more suited to changing climate conditions or diversification in horticulture and vegetables); and better extension services (for example, to raise awareness and improve the capacity of farmers around climate-smart technologies and practices, such as precision irrigation). Overall, public funding is comparatively low and as a long-term goal Pakistan could increase spending on the Agriculture Innovation System (AIS) to at least 1 percent of its agriculture GDP (some of which could be funded through a reshuffling of costly subsidies to the sector).

Toward Resilient Growth

To enhance resilience to disasters, the federal and provincial governments in Pakistan could opt for the following key policy choices in the short term:

- **Strengthening the capacity of DRM authorities**, particularly by establishing and operationalizing district- and city-level disaster management authorities. The district and local administrations are usually the first responders in a disaster situation and also have the closest links with communities. Furthermore, there is a need to streamline roles, responsibilities, and mandates of various institutions involved in DRM as part of strengthening the overall institutional framework.

- **Completing multi-hazard risk assessments across the country** to identify the risk environment, as the first step toward moving to risk-informed planning and decision-making.

- **Putting in place a disaster risk financing (DRF) program,** which would entail a mix of financial instruments to protect the country from fiscal shocks because of natural disasters. The first step would be to develop national and provincial DRF strategies to set out DRF priorities for the next five years.

- **Increasing the amount of climate knowledge available in the country** through specific and targeted analytical work and awareness initiatives. Pakistan's international commitments on climate change, that is, Nationally Determined Contributions (NDCs), should be unpacked in the form of an implementation road map and investment plans for key sectors.

In the long term, Pakistan could follow the following key choices to complement and deepen short-term measures:

- **Directing investments toward risk mitigation infrastructure to reduce the potential risk of disasters and climate impacts**, such as hydrometeorological and seismic disasters. Infrastructure should also contribute toward meeting Pakistan's NDC commitments for adaption and mitigation.

- **Mainstreaming risk in planning. Climate and disaster risks should become an integral part of short- and long-term planning in the country**. Climate-sensitive planning should be promoted across all public sector institutions, for sustainability of development initiatives, and to ensure that climate change is included as a key issue in the national narrative.

INTRODUCTION

Pakistan@100 is an initiative to contribute, through analysis, to a debate on Pakistan's main long-term development challenges and opportunities. This policy note focuses on many areas that are crucial for long-term growth from an environmental sustainability point of view, allowing for an analysis and discussion of some key choices and reform options. Pakistan has a mixed record of reform implementation. Recognizing this, the policy note also seeks to understand why previous reform efforts have not delivered the expected results.

The preparation of this policy note has involved significant efforts in outreach and partnering with local stakeholders to increase ownership of the analysis and recommendations, as well as the relevance of the ensuing discussions. In addition to the review of documentation, the World Bank team conducted interviews with key stakeholders in Pakistan belonging to the Government, civil society, and academia. The potential reforms were discussed in a focus group led by the Sustainable Development Policy Institute (SDPI) during a workshop held in March 2018 in Islamabad. An earlier draft of this note was discussed at a two-day event at the Lahore University of Management Sciences in March 2018.

This policy note focuses on the key sustainability issues, their status, trends and policies, and institutional reforms that could help address growing challenges, which put at risk aspirations for faster growth and poverty reduction. For this purpose, the policy note is structured around three sections that center on a triple sustainability message: (i) urbanization will grow, but it is possible to live in healthy cities; (ii) water demand will grow, but it is possible to have enough water for food security and other uses; and (iii) as Pakistan's population and assets grow, so will economic exposure to disasters, but it is possible to build resilience.

Each section of the policy note explores select issues that are core to an environmentally sustainable, greener, and climate-smart growth path: (i) managing air and water pollution (Toward Healthy and Productive Cities); (ii) Managing Land and Water Sustainably (the agriculture and water nexus); and (iii) Building Resilience to Natural Disasters. The section 'Toward Healthy and Productive Cities' emphasizes the links between productivity and environmental health, considering air pollution and WASH issues, and improved water and sanitation service delivery (including health and productivity impacts). The section 'Managing Land and Water Sustainably' stresses the importance of fixing governance, institutions, and water management systems on the policy side to allow the agriculture sector grow in a sustainably way, as water is essential for agricultural development. Finally, the section 'Building Resilience to Natural Disasters' expands on institutional issues, federal/provincial relationships, and an array of instruments/solutions for disaster risk financing, including insurance and cash transfer mechanisms.

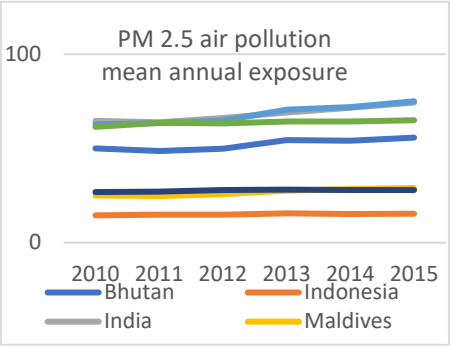
CHAPTER 1: TOWARD HEALTHY CITIES & PRODUCTIVE CITIZENS

Air and water pollution are two critical factors that deteriorate environmental health in Pakistan. Urban air pollution due to fine particulates is a serious problem in Pakistan, as both stationary and mobile sources (many of which are part of the industrial supply chain) contribute to emissions of fine particulate matter (PM). PM 10 refers to particles with a diameter between 2.5 and 10 micrometers, and fine particles, or PM 2.5, have a diameter of 2.5 micrometers or less. Many areas in Pakistan lack acceptable water supply and even more people have inadequate sanitation. Inadequate water supply and sanitation are the main reasons of microbiological water pollution that causes a range of diseases that are often life threatening. The problems of water supply and health are intensified where industrial pollutants contaminate water systems because treatments that control infectious agents are not effective in removing many toxic chemicals from drinking water. Sources of drinking water may be contaminated because of the lack of regulated municipal waste collection systems. There are hundreds of industrial and household chemicals, pharmaceuticals, and pesticides in water systems. The worst biological and chemical pollution of drinking water is seen in rapidly urbanizing and industrializing Pakistan, where local waterways and groundwater are heavily polluted and serious health conditions are widely reported, but no alternative water sources exist.

In the past decade, Pakistan has not been able to mitigate the costs of environmental degradation, creating additional challenges to rapid economic growth. Indoor and urban air pollution and water pollution affect human health and productivity. Air and water pollution are major driving factors behind high environmental health costs, productivity losses, and natural resource degradation that hinder economic growth and negatively affect the competitiveness of Pakistan's economy. The impact of air and water pollution is disproportionately larger for the poor and vulnerable, particularly women and children.

To identify the best avenues for greening Pakistan's growth and improving environmental health, this section focuses primarily on air and water quality. These two dimensions of environmental policy-making were chosen because of their high cost to the economy and their trans-regional impacts. These two dimensions are particularly difficult to manage and have triggered a public outcry for better control by the authorities. Furthermore, building a greener development path that addresses these issues will require smart, sequenced environmental management solutions at all governance levels, with significant contributions to the country's climate change priorities

Figure 1. Mean Annual Exposure to Air Pollution in South Asia, Measured as Exposure to PM 2.5



Source: World Bank WDI database.

and Nationally Determined Contributions (NDCs).[2] First, this policy note discusses ambient air pollution, which affects growing urban centers the most and is currently not monitored in Pakistan. Second, the note examines WQM, because while access has steadily increased for both urban and rural populations, water quality remains poorly monitored and governed. Furthermore, the analysis of access to water supply, sanitation, and hygiene (WASH) provides a window into the distributional aspects of environmental public service management in Pakistan. The note then reviews the lessons learned from the reform experience in AQM and WQM, and provides policy recommendations.

1.1 POOR & DETERIORATING AIR QUALITY: THE TOP PUBLIC HEALTH CONCERN

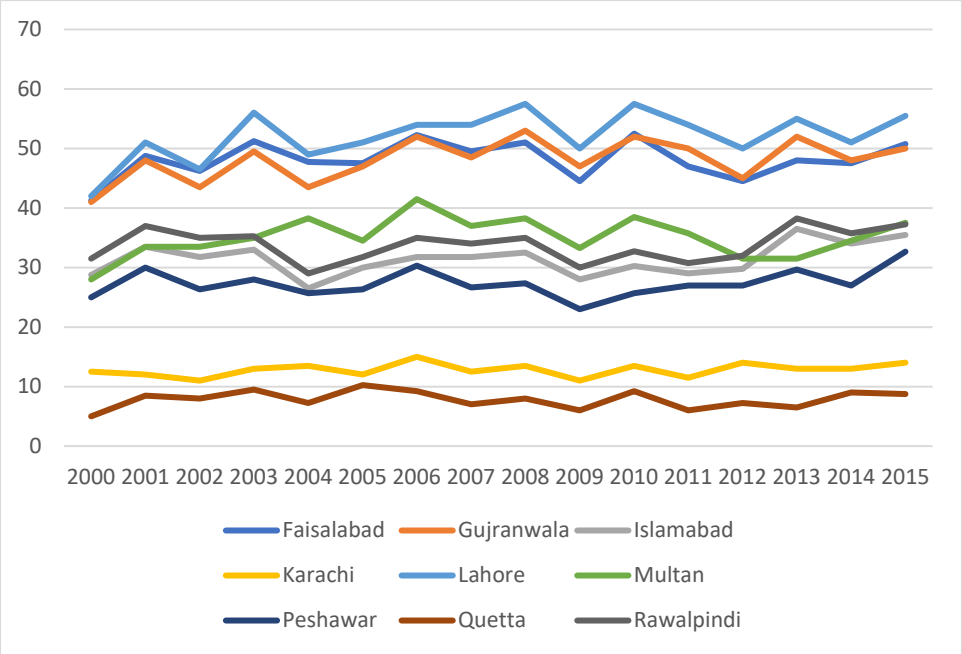
Profile of Air Quality

In Pakistan, air pollution is very high, and this affects health and economic growth. Air pollution is recognized as the greatest environmental risk to health (UNEP, 2017), and has emerged as a leading cause of death and ill-health globally. In 2015, diseases caused by air pollution were responsible for an estimated 16 percent of all deaths worldwide (Landrigan, et al. 2018). Beyond the impact on health, urban pollution subtracts from the benefits of agglomeration economies for growth. Air pollution is also linked directly to lower on-the-job productivity of workers (Chang et al., 2016). The Environmental Performance Index (EPI) (Yale Center for Environmental Law and Policy, NA), which tracks global environmental trends and progress, ranks Pakistan 176 out of 180 countries in terms of air quality. In the South Asia Region, Pakistan ranks as one of the countries with the highest levels of exposure to pollution, measured as mean annual exposure to PM 2.5 (Figure 1). Air pollution levels are increasing and particularly high for the Karachi/ Hyderabad areas.

In Pakistan's cities, the levels of PM 2.5 are concentrated in a range that is 2 to 14 times higher than the local and World Health Organization (WHO) standards. An analysis of the available data for 2007-10 show very high concentrations of fine particle matter (PM 2.5) in Lahore (143 $\mu g/m^3$), Peshawar (71 $\mu g/m^3$), Karachi (88 $\mu g/m^3$), Islamabad (61 $\mu g/m^3$), and Quetta (49 $\mu g/m^3$) (Sánchez-Triana et al., 2014). By comparison, according to the WHO, annual mean PM 2.5 pollution in Beijing is 85 $\mu g/m^3$ (WHO, 2016). These levels vary seasonally due to different factors such as sunlight and heat, thermal inversions and ground fog during the winter months, and 'dust cloud' formation during summer.

[2] NDCs are at the heart of the Paris Agreement of 2015, where 196 parties came together to transform their development trajectories, aiming at limiting warming to 1.5°C to 2°C above preindustrial levels.

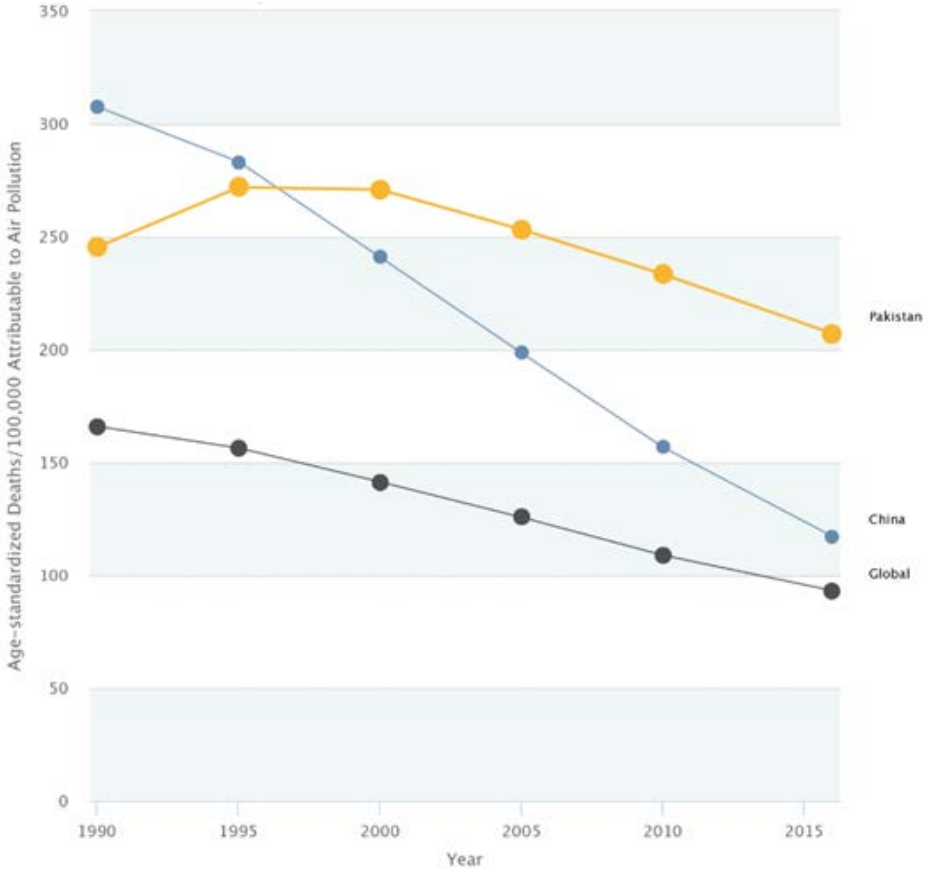
Figure 2. Estimated Mean PM 2.5 Concentrations in Pakistan's Cities, 2000-15



Source: Van Donkelaar et al, 2017.

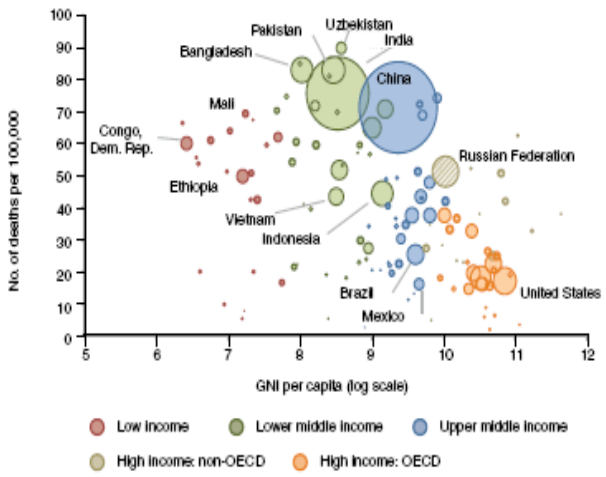
The economy of Pakistan is very air pollution intensive, with grave consequences for both productivity and public health. Pakistan already surpasses China's population-weighted PM 2.5 by 25 percent, but its gross domestic product (GDP) per capita is five times smaller. In Pakistan, it takes US$18.9 of GDP per capita to generate 1 unit of PM 2.5. In China, 1 unit of PM 2.5 is associated with US$145 of GDP per capita. The health costs and productivity slowdown of air pollution will continue to burden Pakistan's economic growth. The rate of deaths attributable to air pollution (including indoor, PM 2.5, and ozone) in Pakistan is also well above global averages and decreasing far more slowly than elsewhere. Based on a simple extrapolation made by the authors and assuming a 'business-as-usual' scenario, by 2050 (Figure 3), if Pakistan is to maintain this death rate but also achieves upper-middle-income levels, it would see an increase in the number of deaths from around 200,000 now to between 500,000 and 1.5 million per year. Even if air pollution were to remain at the same levels, the deaths are expected to continue to rise at the same rate as urbanization growth, which is currently at 3.2 percent annually.

Figure 3. Age-Standardized Deaths per 100,000 Attributable to Air Pollution, 1990 To 2015



Source: Yale Center for Environmental Law and Policy, Environmental Performance Index

Figure 4. Ambient PM 2.5 Death Rate Versus Income



Source: World Bank, Institute for Health and Metrics Evaluation 2016.

Note: Size of bubble corresponds to the total number of deaths.

The dangerously high concentrations of PM 2.5 in Pakistan are associated with high costs to human health, ranging between 2.5 and 6.5 percent of GDP equivalent in welfare losses (Elena, 2018). This policy note focuses on PM 2.5 values as the main indicator for outdoor air pollution, because PM 2.5 is associated with the largest health effects. Even considering the income level, Pakistan's concentration of PM 2.5 is exceedingly high compared with other countries (Figure 4). The mean annual pollution exposure increased by more than 26 percent between 1990 and 2013, while total welfare losses more than doubled from 20 million to 48 million USD (Sánchez-Triana et al., 2014). The Institute for Health Metrics and Evaluation's Global Burden of Disease Project and the Health Effects Institute had estimated that in 2015 there were 124,577[3] deaths and a 2,906 rate of disability-adjusted life year (DALY)[4] losses per 100,000 associated with outdoor air pollution.[5]

Within cities, the burden related to outdoor air pollution is expected to be even higher due to high concentration and exposure. In Sindh, for example, it was estimated that, in 2009, there were 9,000 premature deaths and the cost of health effects was between PKR 30 billion and PKR 75 billion. Of those, 80 percent were in Karachi (Sánchez-Triana et al., 2014). In addition, AQM directly causes lower on-the-job productivity in both low and high skilled sectors (Chang et al., 2016). This research suggests that a 10-unit increase in the air quality index (AQI) above the WHO level decreases productivity by 0.35 percent (Chang et al., 2016). Given the extraordinarily high AQI for Pakistan's cities, the costs associated with lowered on-the-job productivity are likely to be very high.

[3] The number of deaths attributable to ambient PM pollution. PM 2.5 and tropospheric ozone (that is, ozone found in the atmosphere nearest the earth, where we live and breathe) are the two indicators used to quantify exposure to outdoor, or ambient air pollution in the Global Burden of Disease Project.

[4] The WHO definition of DALY can be thought of as one lost year of 'healthy' life. The sum of these DALYs across the population, or the burden of disease, can be thought of as a measurement of the gap between the current health status and an ideal health situation, where the entire population lives to an advanced age, free of disease and disability.

[5] The DALY per 100,000 should be compared with 1,469 in China and 2,651 in Bangladesh. Data were obtained from https://www.stateofglobalair.org/data. The Global Burden of Disease Project takes advantage of the monitoring data available from the WHO Global Urban Ambient Air Pollution Database. The numbers of deaths attributable to air pollution, in a given year, include deaths that have likely occurred months or even years earlier than might be expected in the absence of air pollution (as in the case of a child dying from a lower respiratory infection).

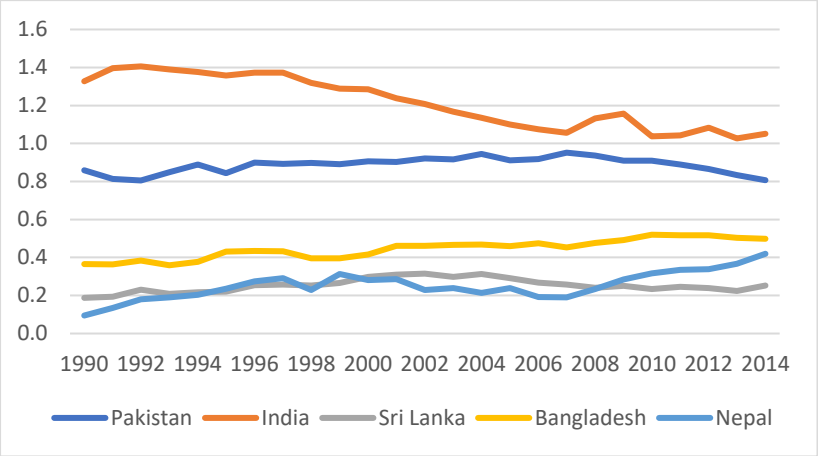
Indoor air pollution is associated with high annual mortality rates and health costs in Pakistan's peri-urban and rural areas, with disproportionately high impacts on the poor and vulnerable. In 2013, there were nearly 3 million deaths and 3 percent of global DALYs associated with indoor air pollution and over 40 percent of the world's population was exposed to it, particularly in South Asia, largely due to the use of solid fuels for cooking and other uses (World Bank, 2016c). In Pakistan, the use of solid fuels for cooking is presently concentrated in rural areas, within 85 percent of households, while in urban areas only 13.5 percent of households use solid fuels (Elena, 2018). Generally, women are more vulnerable to indoor air pollution as they are primarily responsible for cooking in the household. The total annual mortality attributed to household air pollution in urban Pakistan is estimated at about 7,500 cases and about 56,000 cases in rural Pakistan. In total, about 114,000 people die annually due to air pollution, about 46,000 in urban areas and 68,500 in rural areas of Pakistan.

Air pollution and climate change are intertwined, and the risks of climate change to economic growth are well documented. As shown in a 2011 assessment by UNEP and the World Meteorological Foundation, short-lived climate pollutants, particularly black carbon, methane, tropospheric ozone and high global warming potential hydrofluorocarbons, are responsible for a significant fraction of near-term climate change.

Exposure to ozone is also associated with health impacts, particularly in terms of impacts on chronic lung diseases, as well as impacts on the ecosystem. Ozone concentrations in Pakistan have steadily increased since 1990. Ground level ozone is not emitted directly into the atmosphere, but instead is formed by through oxidation of air pollutants, including methane, nitrogen oxide (NOX), carbon monoxide, and non-methane volatile organic compounds, some of which are co-emitted with black carbon. Pakistan is one of the countries with the largest increase in seasonal average population-weighted ozone concentrations in the past 25 years.

Managing air pollution also contributes significantly to climate change mitigation. Both air pollution and greenhouse gases (GHGs) are driven by the road transportation sector, and thus managing air quality also contributes significantly to meeting NDCs. Road traffic is the main source of PM 2.5 in Pakistan, while it also contributes 23 percent of all CO_2 emissions (Sánchez-Triana et al., 2014). While emissions of GHGs from Pakistan are significantly lower than those from developed countries, it produces more GHG emissions per GDP than other countries in the region, with the exception of India (Figure 5). Fossil fuel combustion accounts for more than 90 percent of total CO_2 emissions and for 40 percent of the overall GHG emissions in Pakistan. Within the emissions produced by fuel combustion, the transport sector accounts for 23 percent of all CO_2 emissions, of which the road sector takes the largest share (97 percent) due to its continued dependence upon CO_2 intensive fuels. In addition, most of the transport sector GHG emissions originate from road transportation. Road transportation accounts for more than 90 percent of transport GHG emissions (Sánchez-Triana et al., 2014).

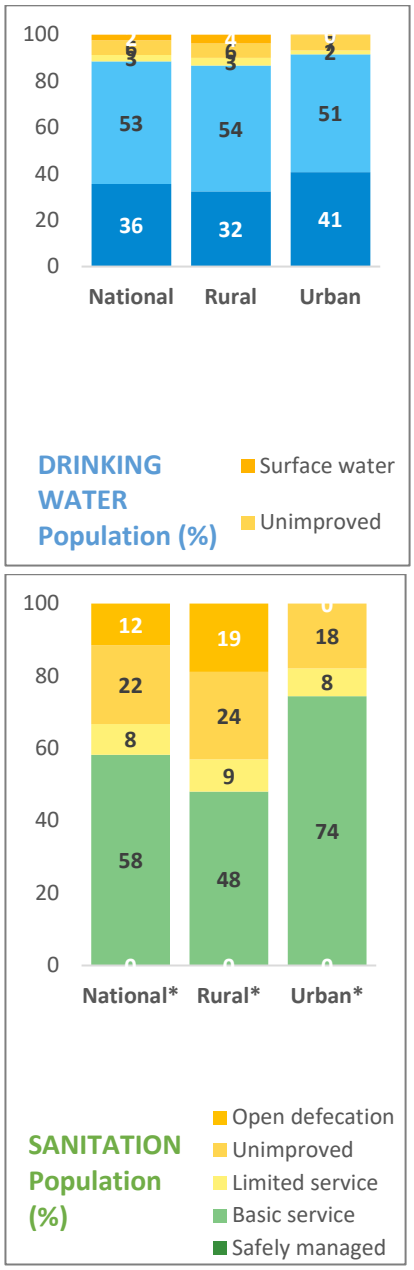
Figure 5. CO_2 Emissions (Kg per 2010 US$ Of GDP), 1990 To 2014



Source: World Bank: World Development Indicators.

1.2 PAKISTAN'S WATER: DETERIORATING QUALITY & POOR SERVICE DELIVERY

Figure 6. Access to Water and Sanitation



Source: UNICEF/WHO Joint Monitoring programme.

Note: Data on percentages of safely managed sanitation are not available.

Increase in economic activity, rapid urbanization, and climate change make water availability and quality a key factor for Pakistan's future growth. The country has been growing and urbanizing rapidly, and it is estimated that about 50 percent of the population will be living in urban areas by 2030 (Sánchez-Triana et al., 2015). This is placing a significant strain on the availability of water and its quality. Surface water supplies are increasingly threatened by wastewater pollution. In 2013, only 50 percent of effluents were being collected and only 10 percent of those collected were treated (World Bank, 2013b). Groundwater is now being overexploited in many areas and its quality is deteriorating. The increase in economic activity, urbanization, and climate change have coalesced to make concerns over water availability and quality a key factor of Pakistan's future growth.

Profile of Water Supply and Quality

On the EPI, Pakistan ranks 140 out of 180 countries in water and sanitation, with only 36 percent of the population having access to safely managed drinking water. The percentage of the population with access to improved water sources[6] has remained in the low 90s for the last 15 years—it was 91.7 percent in 2000 and 91.3 percent in 2015. Access to piped water (not necessarily clean) decreased from 38.9 percent in 2013 to only 27 percent in 2015. In addition, there is generally no continuous 24/7 water supply. In 2012, the hours of operation varied in urban centers between 4 and 17 hours a day. Causes vary, but high levels of leakage, limited supply, insufficient access to power due to capacity, or a lack of payment all make water utility services intermittent.

[6] For a discussion on the definition of the water source for the Millennium Development Goals and Sustainable Development Goals see, for instance, https://blogs.worldbank.org/opendata/adding-existing-mdg-drinking-water-data-sdg-world

Access to improved sanitation services was at 70.6 percent as of 2013, but declined to 63.7 percent of the population by 2015 (WHO and UNICEF, 2017**).** Flush toilets are the most common type of sanitation facility among households, with access reaching 73.4 percent. However, the differences between urban (96.9 percent) access and rural (59.7 percent) access is nearly 30 percent. Nearly 20.2 percent of urban and 13.6 percent of rural areas have unsanitary drainage flowing directly into the nearby environment, with no sewer, septic tank, or pit.

Increase in wastewater treatment has been slow, from 3 percent of wastewater in 2006 to 50 percent of effluents being collected and only 10 percent of those being treated by 2013 (World Bank, 2013b). It has been estimated that about 308 million m^3 of municipal and 185 million m^3 of industrial wastewater is generated annually, but only 3 percent of that was being treated in 2006, whereas 185 million m^3 was disposed of directly into water bodies (Kahlown et al., 2006). About 30,000 ha of land is irrigated with wastewater and 25 percent of the vegetables consumed in Pakistan are produced through wastewater irrigation (Korea International Cooperation Agency, 2017). Beyond the risk to farmers themselves, post-harvest contamination in markets can be a key factor affecting public health (Dickin et al., 2016). On wastewater treatment, Pakistan ranks 139 out of 180 on the EPI.

Pakistan's urban-rural and income quintile differences in access rates to improved water and sanitation are higher than the international benchmarks. The differences in access to improved sanitation and piped water, evaluated in 2017, for Pakistan are illustrated in Figures 7 and 8 (World Bank, 2017a). The urban-rural gap is at about 30 percentage points, which is above the international benchmark of about 25 percent. Similarly, the difference in access for the top and bottom income quintiles is 35 percentage points for Pakistan, with the international average calculated in this study at 24 percentage points. According to the joint WHO and UNICEF report (WHO and UNICEF, 2017), inequality in access to hygiene in Pakistan correlates closely with the income scale, far more so than in most other countries.

Figure 7. Access to Piped Water on Premises, By Urban and Rural, Selected Countries

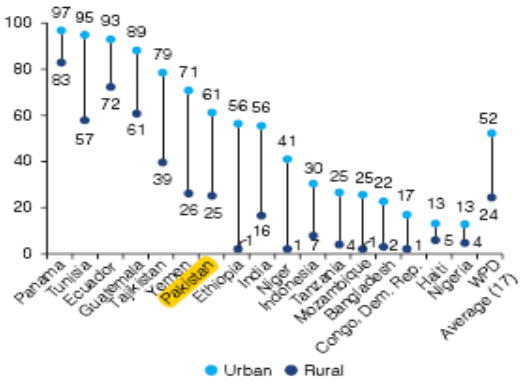
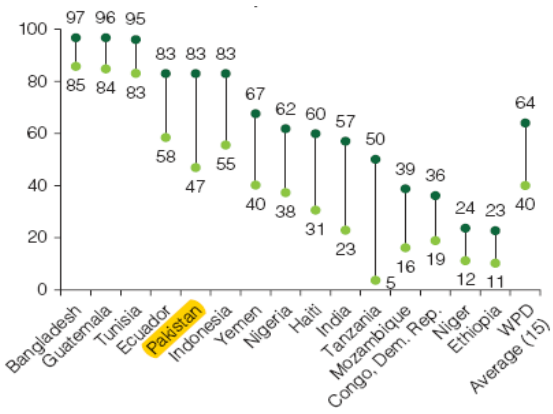


Figure 8. Access to Improved Sanitation, By Wealth Level, Selected Countries



Source: World Bank, 2017a.

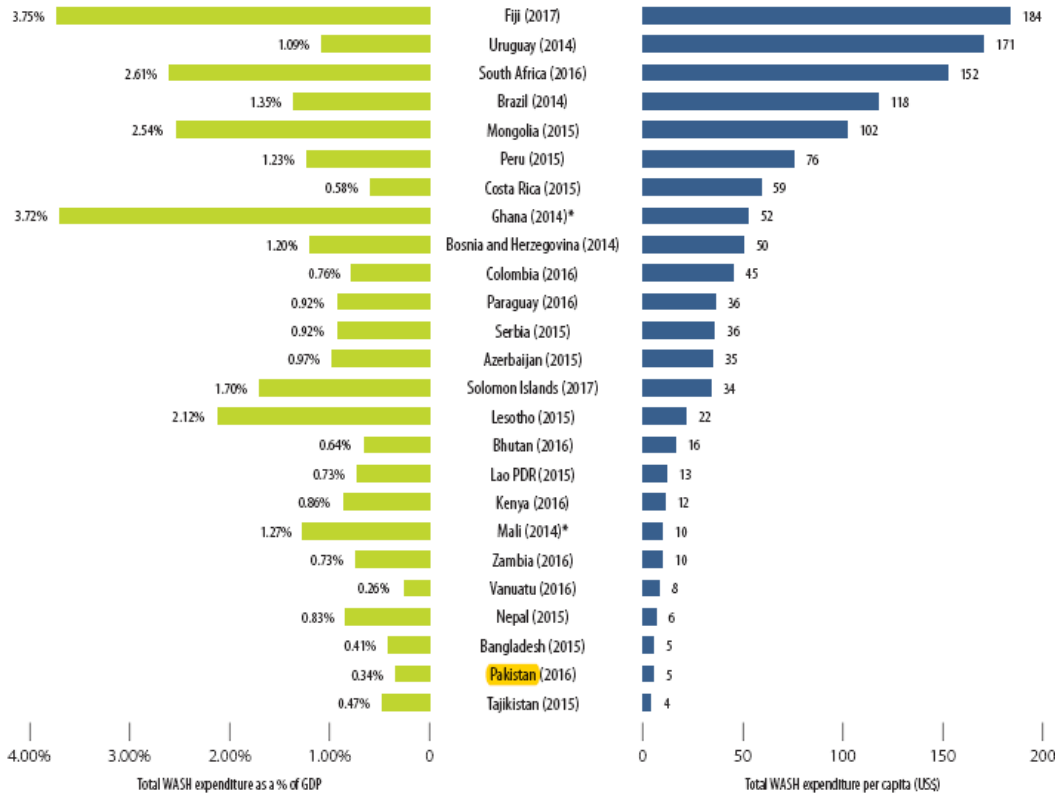
Impacts of Water Availability and Quality

The inadequate quality of drinking water has increasing health socioeconomic consequences for Pakistan's growth, particularly in rural areas. As of 2006, 20 to 40 percent of hospital beds were occupied by patients suffering from water-related diseases, such as typhoid, cholera, dysentery, and hepatitis, which were responsible for one-third of deaths (World Bank, 2006). Based on those assessments it was estimated that the total health costs associated with the deaths and sickness caused by waterborne disease in 2006 amounted to more than 1.8 percent of GDP equivalent (which is expected to grow to 6 percent by 2050). As of 2016, the annual cost of inadequate WASH in Pakistan was estimated to be US$2.4 billion in urban areas (0.9 percent of GDP) and US$5.1 billion in rural areas (1.8 percent of GDP in 2016).

Household tariffs contribute about 20 percent of the funding for WASH, whereas an international average would be about 66 percent. According to the Global Analysis and Assessment of Sanitation and Drinking Water (GLAAS), an annual analysis conducted by the WHO and the United Nations, households contribute the most to the WASH sector, predominantly through tariffs, and self-supply solutions such as wells, water tanks, and septic tanks. In a sample of 25 countries analyzed in the GLAAS 2017 report, an estimated 66 percent of funding for WASH originated from household sources, about 75 percent of total expenditure on water, and 57 percent of total expenditure on sanitation. In neighboring Bangladesh, households contribute 54 percent of the nation's total expenditure on WASH. However, households in Tajikistan and Pakistan contribute only 16 and 23 percent, respectively. Cost recovery has been improving slightly in Pakistan from below 20 percent, but it is still, on average, insufficient to ensure sustainability of public service investments. Local authorities, which are responsible for WASH service provision in Pakistan, are 70 to 80 percent dependent on the allocation from annual provincial budgets.

WASH subnational allocations are not linked to access rates at the district level. In Pakistan, the lion's share of overall intergovernmental transfers goes to provincial capitals, which are among the richest districts in the nation. Even when provincial capitals are excluded from the analysis, there is no relationship between district-level poverty levels and resource allocation. This pattern holds for WASH-specific investments as well. Districts where a relatively large share of households have access to improved water and sanitation benefit from a higher rate of WASH expenditure per capita than districts where access rates are low. While this is partially explained by the higher operation and maintenance expenses in high-access districts, it is indicative of underinvestment in water and sanitation infrastructure in low-access districts.

Figure 9. Total WASH Expenditure as Percentage of GDP and Per Capita in 25 Countries



Source: United Nations-Water, WHO. 2017.

The highest returns on expenditures in terms of reduced risk for under-5 mortality would be in Balochistan. A model developed by the Water and Sanitation Program (World Bank, 2006) has estimated where WASH investments would have the greatest impact, with regard to the potential effects of reducing the risks of under-5 child mortality from diarrhea analyses improvements at the province level in Pakistan. The model suggests that children from Balochistan would experience the greatest risk reduction in response to these improvements, but all provinces would benefit.

1.3 LESSONS LEARNED FROM PAST REFORMS

Several institutional, financial, and capacity issues have undermined the success of past environmental reforms in Pakistan. Environmental planning and monitoring could not be sustained and without this key function, in the hands of weak environmental institutions, environmental problems such as pollution could not be managed against existing or new standards. A lack of accountability and transparency in the different levels involved with environmental management and a lack of citizen engagement, public consultations, and disclosure have not served to improve enforcement. Complex environmental problems are still being managed using an old-fashioned approach, without considering the scope of airsheds and watersheds. The failure of past reforms has also been underpinned by the lack of interjurisdictional and intersectoral coordination. Finally, the phenomenon of 'elite capture' has contributed to restricting systemic changes in environmental institutions and reducing compliance with the regulations and behavioral changes by polluters. The following points illustrate some specific lessons learned:

- **Environmental standards were established without assessing their feasibility or providing for monitoring and enforcement.** The National Environmental Quality Standards (NEQS) were first developed in 1993 and later revised in 2000 and 2009. Apart from the PM and arsenic standards, the NEQS are largely in line with WHO standards, though the feasibility of meeting them was not assessed. These standards are not being properly monitored and evaluated due to institutional difficulties. As of mid-2014, the provincial Environmental Protection Agencies (EPAs) had not assumed the operation and maintenance costs of the air quality monitoring network that was developed by the Government of Pakistan (GoP) between 2006 and 2009 with the aid of the Japanese International Cooperation Agency (JICA). In mid-2012, the monitoring network suspended its operations because of the EPAs' failure to cover its operations and maintenance costs. With regard to water quality monitoring, the regional authorities perform some monitoring of drinking water, though not on an annual basis. Similar to the environmental standards, the 'polluter pays' principle, established in 2001, was not supplemented with appropriate monitoring (currently only voluntary) and enforcement mechanisms.

- **Various reform efforts failed to lead to an improvement in environmental quality due to a lack of legislative clarity, institutional mechanisms, and funding.** With devolution in 2010, the right to legislate and regulate environmental matters fell exclusively to the provinces. The provinces amended the federal Pakistan Environmental Protection Act (PEPA) of 1997 and enacted it as a provincial environmental act. Punjab, for instance, even endorsed its first Environmental Policy in 2015, which was followed up by an environmental action plan. While devolution provide significant potential for effective environmental management, it has been mired in coordination, funding, and capacity difficulties. The federal government retains authority over some matters, which has caused a lack of clarity and accountability. At the provincial level there is an acute lack of capacity in terms of staffing, training, and funding. For example, provincial EPAs faced difficulties retaining the technicians trained in the proper operation of the monitoring

equipment under the JICA program, as well as calibrating and interpreting the data generated by the monitoring stations. The devolved responsibilities have not been matched by funding, which caused the collapse of the air monitoring system.

- **Gaps in policy and enforcement have been filled by the judiciary branch in response to the growing public demand for better environmental management, instead of the institutions with a core environmental mandate.** The Supreme Court of Pakistan has considered cases regarding the degradation of the environment and has concluded that the right to a clean environment is a fundamental right of all citizens of Pakistan. The high courts in the provinces have also intervened and rendered decisions affecting future environmental management. For example, the Lahore High Court appointed the Lahore Clean Air Commission to develop and submit a report on feasible and specific solutions, and measures for monitoring, controlling, and improving vehicular air pollution in the city of Lahore. In addition, two provincial environmental tribunals have been instituted in Karachi and Lahore, but have been hindered by legal loopholes and a lack of mechanisms for collecting imposed sanctions. A concerted, strategic policy is needed to respond to citizens' growing demand for a cleaner environment as Pakistan becomes an upper-middle-income country.

- **Some key regulations, such as the Pollution Charge Rules 2001, could not be implemented due to resistance from interest groups and a lack of political will**. Institutional reforms in countries with unequal distribution of power may be hindered by members of the elite who benefit from the existing economic and political institutions (Governance Note). Such an elite opposes institutional reforms that threaten its political power. Resource inequality also enables the elite to subvert the political, regulatory, and legal institutions for its own benefit and leads it to favor established institutions over new efficient ones. Pakistan's complex history has favored some conditions for elite factions with their own agenda, such as the industrial one. In Pakistan, these behaviors may have perpetuated the status quo of environmental management and lack of progress toward sustainability. The key institutional reforms that could have been undertaken, such as those that involve revamping environmental institutions, deepening decentralization, enforcing standards, would have gone against perceived interests related to key productive sectors, such as industry or agriculture.

1.4 KEY POLICY CHOICES

Environmental degradation is not only threatening environmental sustainability, but also Pakistan's ability to tackle poverty, as well as its ability to generate a substantial share of its growth and employment. Similarly, while Pakistan needs to think in the long term with regard to environmental sustainability, many of the actions it could take to control and reverse environmental degradation and adapt to climate change would have immediate benefits and be particularly helpful to the poorest, who are most vulnerable.

However, based on lessons learned from past reforms, there are several policy choices that Pakistan could make in the short to medium term around the following key areas:

- Countries cannot manage what they do not measure. Improving monitoring is crucial.
- There is an opportunity for Pakistan to make devolution work for a better environment.
- Environment is everyone's business and coordination among stakeholders and institutions is essential.
- Greening investment is key in the context of growing investments needs.
- Harnessing the power of public pressure to improve accountability and transparency in institutions in different levels will help drive reform.

A country cannot manage what it does not measure and improving monitoring is crucial. Pakistan needs to improve its overall environmental monitoring, which is currently weak. A key mandate of EPAs, as part of their core functions, is environmental monitoring. The first step is to understand the current pollution levels and sources by rebuilding the monitoring network not only with equipment, but also with protocols, analytical capacity and technical, institutional, and financial sustainability. To plan an effective pollution reduction action plan, the authorities need to understand the current pollution levels, concentration, trends, and sources. Monitoring is instrumental for planning, implementation, and evaluation of progress made. Realistic standards can neither be set nor enforced without knowing the levels of pollution.

To build a robust database of air quality data, the GoP must assign resources for developing an inventory of mobile, industrial, and stationary sources. For water quality data, the ideal system would be tiered, including routine sampling by the operator and monitoring by the local or provincial health or environmental authorities, with oversight, review, and consolidated reporting by the national environmental authority. As monitoring systems become more reliable, the pollution data will allow the GoP to model the transport, dispersion, and fate of pollutants, and make informed decisions on the sequencing of reforms and interventions for pollution control. A strong monitoring system starts with adequate human resources capacity.

Box 1. A Target to Emulate: The Case of China

China started a battle against air pollution through its five-year plans, for example, by setting specific PM 2.5 targets, especially in the 2016 plan. Other main targets include reduction of emissions from coal burning industries and vehicles; boosting of cleaner and more efficient use of coal; promotion of the use of electricity and natural gas in place of coal; support for wind, solar, and bio power sectors; increase in proportion of clean energy; encouragement for the use of waste straw as a resource; reduction in-field burning; and implementation of control measures to deal with air pollution.

China has also aligned these plans with economic growth to achieve green growth by reducing energy and resource intensity and decoupling the emissions of key pollutants from economic growth and urbanization. Since the implementation of the five-year plan, the service industry has grown considerably, energy intensity per unit of GDP has fallen by 18.2 percent and emissions of key pollutants have dropped by over 12 percent.

In China, local governments have traditionally had three functions: to manage public services, social welfare, and market regulations. A fourth important function, environmental protection, is being added to that list.

Source: http://www.climatechangenews.com/2016/03/11/chinas-five-year-plan-to-radically-tighten-air-pollution-targets/.

Box 2. Deepening the Devolution: The Case of Punjab

Some provinces in Pakistan are taking a leading role in the structural transformation toward better environmental governance and green investments. The Government of Punjab has recently developed a broad program to address environmental issues and promote green development in Punjab in the short, medium, and long term. This program is presented in recent strategic documents adopted by GoPunjab, such as the Punjab Environment Policy 2015, the Punjab Smog Policy 2017, and the Punjab Climate Change Policy (under preparation). The objectives of these policies are to improve environmental quality in the province and reduce air, soil, and water pollution; address deforestation, floods, and land degradation; manage surface water and groundwater resources; conserve natural resources and protect biodiversity; promote sustainable urbanization and industrialization; develop public transportation and other alternatives to private motorized vehicles; integrate environmental considerations in public policymaking and private investments; comply with international standards and enhance green competitiveness; and promote resource and energy efficiency. The EPD is the main department responsible for ensuring the implementation of these policies, in coordination with relevant line departments. Institutional improvements under this program include restructuring and capacity building of EPD, establishment of an environmental technology center, establishment of an environmental monitoring center, capacity building for air and water quality monitoring, policy and regulatory reform, public disclosure, awareness raising and citizen engagement, green financing strategy, and demonstration of resource-efficient and clean production technologies.

Source: Punjab Green Development Program - Project Appraisal. Document (2018).

A first step will be recruiting or training enough staff with the expertise and background required for air quality management Furthermore, increased engagement with research centers and academic networks could foster interest and ensure that there are opportunities for young professionals to enter the field. Fostering a partnership with universities to participate in monitoring efforts can have lower administrative costs, employs existing expertise, helps create new experts, and builds in more transparency. The use of disruptive technologies can facilitate data generation and data access, such as the use of remote sensing in combination with deterministic modeling, the use of mobile devices and mobile labs, and the use of large spatial datasets and analytical tools. Monitoring networks, as those operating in the airshed of the city of Beijing, in China, represent a good example.

There is an opportunity to make devolution work for a better environment in Pakistan. The case to deepen devolution for environmental management in Pakistan is clear: high population growth rates, patterns of migration, and rapid urbanization make local governance necessary to manage the country's sustainability challenges. These challenges, such as air or water pollution, vary by region, have different urban-rural characteristics and, therefore, demand a more grassroots level of policy-making and implementation. Citizens also have a better understanding of good governance and are aware on the importance of accountability and transparency—a trend that explains greater demand for decentralized governments that can be responsible for local public service grievances.

This process could start by focusing on the institutions with a core mandate on environmental mandate, such as the provincial EPAs. These entities have pressing needs of institutional strengthening, capacity building, and reform. Strengthening planning and financial capacity is a critical measure. A better capacity will allow the provincial governments to make use of the monitoring data, and develop and implement an action plan for pollution reduction. To improve EPAs' priority setting, these entities might consider areas such as: (i) restructuring and capacity building, including AQM/WQM planning with appropriate labs and models along with the protocol and technical/financial capacity to maintain them; (ii) regulatory reform; and (iii)

information disclosure and citizen engagement. Provincial environmental entities can also play a key role beyond enforcement and can contribute in the development space by improving their capacity to: (i) promote green financing and mainstreaming of green investments in the public sector; and (ii) support the adoption of RECP measures in polluting sectors.

Better environmental institutions will play a key role in the revisions and enforcement of the PEPA, after extensive consultations with stakeholders and adjusted to the reality of the provinces. The PEPA is the backbone for environmental management at the provincial level following devolution. Capable and credible institutions will be in a better position to enforce the NEQS, which will determine the prohibition of discharges of any pollutant more than NEQS and make penalties effective. Better EPAs will also, for example, let the Strengthening Markets for Agriculture and Rural Transformation (SMART) initiative become a binding system. EPAs should also be in a better position to achieve buy-in from the industry and extensive consultation with stakeholders.

Box 3. Forests, a Green Investment to Address Environmental Health and Beyond

Forests play an important role in pollution control, environmental health, water regulation, and communities' livelihood. Therefore, long-term forest investments are required to increase the forest cover and harness the huge potential of forest contributions.

Forests control air pollution by the interception of PM such as dust, dirt, and smoke out of the air by trapping them on leaves and bark, and the absorption of gaseous pollutants (such as carbon monoxide, nitrogen oxides, ozone, and sulfur oxides) through the leaf stomata. According to Nowak et al. (2014), forests in the United States removed 17.4 million tons of air pollution in 2010, with human health effects valued at US$6.8 billion. Research shows that living near urban green spaces and having access to them can improve physical and mental health, for example by decreasing high blood pressure and stress.

Long-term forest investments are required to harness the huge potential of forest contributions to resilient ecosystems, environmental health, rural livelihoods, and the national economy. In recent years, Pakistan has augmented its attention on forests, as demonstrated by the NDC (where forests are prominent for both mitigation and adaptation), the Green Pakistan Program (GPP) at the national level, and the impressive provincial initiative Billion Tree Tsunami Afforestation Project (BTTAP) in Khyber Pakhtunkhwa (KP). The case for future support is to enhance and scale up these new important initiatives in terms of strengthening landscape management, achieving poverty reduction and livelihood improvements, and fostering private sector development.

Provinces can play a key role in deepening decentralization by making environmental aspects a central element of multisector long-term strategies during the preparation of provincial strategies and, in particular, during the preparation of their MTDFs and their Annual Development Plans (ADPs). Environmental and developmental priorities can be translated into concrete activities and expenditures in the Government's MTDF, which is linked to ADPs for each sector. ADPs offer a cross-sectoral platform for environmental mainstreaming (for example, ADPs for industries, energy, transport, irrigation, water and sanitation, urban development, and local government and community development) and can include activities directly contributing to environmental and green development objectives at the provincial and local levels.

However, the improvement with regard to decentralization does not end at the provincial level. It is also important to clarify mandates in urban planning and implementation of cities involved at the air and watershed levels, which are the key spatial units for managing air quality and water. The mandates for urban governance and service delivery overlap between provincial and local governments. In some provinces, new local governments started in January 2017 (Punjab). This represents an opportunity for provincial governments to assess options for decentralizing service delivery to the metropolitan/municipal corporations and municipal committees and creating the enabling legislative and institutional framework to facilitate

environmental management and the provision of environmental services at the local level. There are capacity gaps at the local level and weak autonomy for local governments. Strengthening their systems, including environmental aspects, is the best guarantee to ensure effective decentralization of decision-making, accountability, and unhindered quality service delivery for citizens.

Assuming more leadership by local governments in environmental management, priority measures should be taken through action plans at the city level to address well-understood sources of primary emissions. While data are important, the severity and extent of pollution requires immediate action. Cities across the world have followed a phased approach to their AQM and WQM. The first phase is to address emission quantities that gives priority to well-understood sources of primary emissions in cities. The second phase is to tackle ambient air quality through sources that deliver the largest improvements in ambient air quality, based on source apportionment. The third and fourth phases look at cost-effectiveness and cost-benefit ratios.

Local governments, with the support of provinces, could develop plans with short-term abatement measures, including initial cost-effective green solutions for improving environmental public service provision and reducing environmental degradation. Public authorities should consider developing and enforcing technical environmental standards for the provision of public services (particularly for urban sanitation), traffic control, sustainable urban planning and land use, improvement of infrastructure, and regular sweeping. For these types of measures to be put in place effectively, capacity-building efforts would be needed to strengthen sustainable urban planning and transportation management.

The environment is everyone's business, so coordination mechanisms among federal-, provincial-, and local-level agencies and among sectors need to be effective and well-articulated. Air and water pollution are the result of multiple interventions and causes. The role of PK-EPA, or the role of provincial EPAs originally designed to focus mainly on large point sources is not enough to address these problems. Air quality, for example, is not only about regulating industry, energy, and vehicles, but also about investment in public transport, street and construction dust control (managed by local governments), waste management (managed by local governments), and fuels/stoves used by households and small establishments, as well as agricultural emissions. Even with provincial EPDs/EPAs strengthened, Pakistan has yet to develop the institutional coordination arrangements to manage the environmental challenges such as air quality or water quality, at the airshed and watershed levels, and should do so. Meanwhile, it is important to implement the most conspicuous 'no-regret' actions until these other mechanisms are put in place.

Box 4. The Role of Cities in Airsheds

While the provincial EPAs could provide an overarching framework and overall technical guidance, cities in Pakistan could play a role in establishing monitoring networks and developing AQM plans. Cities would need to identify the main sources of air pollution and devise plans to prevent, control, and abate pollution from these sources to reduce air pollution cost effectively and with time-bound targets. The AQM plans would have to be consistent with broader development investment plans and will require cities to steer their development toward a green growth path. And most importantly, local governments would have to devise policies, establish appropriate institutional structures, and allocate financial resources to implement these plans. And yet, Pakistani cities lack the knowledge, experience, and resources to develop and implement the AQM plans.

Better institutional coordination is necessary between the federal and provincial levels. The central level could improve coordination of policy-making and implementation. This means that in addition to formulating national policies to drive sustainable development, the center could provide strategic guidance to the provinces and link provincial-level initiatives to a broader national vision to avoid fragmentation. Other countries such as Colombia have implemented several more specific coordination mechanisms that fall into two categories: 'carrots', that is, rewards for cooperative behavior, and 'sticks', that is, sanctions for non-cooperative behavior. Carrots are likely to be more effective in the case of resource-poor EPAs and sticks are more likely to be effective in the case of resource-rich EPAs. However, this scheme would make sense in Pakistan if there were a consensus on redefining the role and strengthening the capacity and authority of federal agencies such as PK-EPA to support provincial EPAs, which should be all part of an organized federal environmental system. In addition, a formal dispute resolution mechanism could be established to facilitate the overall process. Possible coordination carrots include enhancing the federal government's ability to co-finance investment projects at the provincial level/city level. In countries with a decentralized environmental structure, co-financing is often the most important tool that national authorities should have to ensure national-provincial coordination. National environmental funds could be an efficient and transparent means of enhancing co-financing.

Box 5. Pakistan Needs to Make Industries Greener and Green Financing is Part of the Scheme

While provinces start a progressive update of the NEQS to approach to the WHO values and work on the design of a strategy for NEQS enforcement, they could also identify, pilot, and demonstrate suitable RECP technologies for industries. The most polluting industries and municipalities will need incentives to monitor, report, and ultimately actively reduce the mass flow rates of pollution discharges. This will create opportunities to employ cleaner production technologies and create green jobs. In the longer term, pollution charges could be considered such that firms pay charges based on both concentration levels and volume flow rates of discharges. The second step involves the distribution of revenues generated by pollution charges toward supporting environmental authorities and green investments, thereby giving environmental authorities the incentives to monitor pollutant emissions and collect pollution charges.

As an existing platform, the Pakistan Environmental Protection Council (PEPC) can become an effective body for providing guidance at the federal level if it sets and follows a meeting schedule and has a clear list of goals to move toward and track. The PEPC's guidance will need to be clear and based on a solid understanding of the pollution data. Furthermore, in the context of devolved authority, the PEPC could provide policy lines or targets and timelines that can be met by provinces in ways they see fit, allowing for flexibility and choice of the most cost-effective measures by provinces. The Council of Common Interest is another existing platform (created by the Constitution) that needs to be prioritized. The Council of Common Interest appears to be the natural candidate to act as a forum to address interjurisdictional environmental issues, as it is constitutionally mandated and generates regular interactions on an equal footing. However, it needs to be strengthened if it is to establish its leadership role to shape the decentralization agenda.

Pakistan needs massive and increased investments for growth, so 'greening' investments are critical. The only way to reconcile investments with sustainability and avoid excessive social/health costs is to make them 'greener' from the beginning. For this, stronger regulation, enforcement and EPAs are necessary but not enough (and growth may even be stalled if these are not combined with other approaches). Regulatory approaches must be complemented by incentives, economic tools, fiscal policies, and financing. Pakistan needs a tax reform for higher

investment, which represents an opportunity to design a greener tax regime that includes, for example, pro- growth, pro-poor environmental and carbon taxes, and the elimination of environment damaging subsidies (removal of subsidies for fuels consumed by motor vehicles and industries).[7] Pakistan also needs to have a better financing regime for industries and SMEs. There is an opportunity to develop green financing that makes access easier for environmentally responsible enterprises/activities.

Recognizing the importance of long-term financing for green investments, Pakistan should support the development of green financing measures. The measures could include: (i) operationalizing the 'State Bank of Pakistan Green Banking Guidelines' for commercial banks to improve their capacity to manage environmental and climate risks associated with their investment portfolio and promote green investments; (ii) designing mechanisms to enhance SMEs' access to finance (enhance credit access and support and incentives to prepare bankable projects); (iii) making better use of public-private partnerships (PPPs); or (iv) mobilizing domestic capital markets as a sustainable source of finance (bonds). The Government of Punjab is moving in this direction with the support of a World Bank-financed operation (Punjab Green Development Program). It is also the time to operationalize environmental funds in provinces provided by the legislation, under independent professional management in line with international best practices. Considering the future and learning lessons from China, Pakistan can start developing a domestic carbon market, which will also facilitate local environmental improvements.

[7] It is important that the introduction of GHG taxes should be preceded by studies that assess the distributional impacts of these measures, ensure thorough consultation and communication with stakeholders of policy steps, and propose mechanisms to mitigate any regressive effects.

Box 6. Financing for Green Growth

In general, green growth can be defined as the means by which the current economy can make the transition to a sustainable economy. It involves promoting growth and development, while reducing pollution and GHG emissions, minimizing waste and inefficient use of natural resources, maintaining biodiversity, and strengthening energy security. To facilitate the development of technologies and the fulfilment of the Green Growth Strategy, the Government of the Republic of Korea first introduced a Five-Year Action Plan (from 2009 to 2013). As part of its Five-Year Plan, the Rep. of Korea committed 2 percent of its GDP each year to create a knowledge and a technological foundation to sustain a green growth economy and tackle the financial crisis through job creation.

The strategy included a program of regulatory, financial, and fiscal reform measures to support a green economy. It also incorporated investment in large infrastructure projects that were essential for the Rep. of Korea and attracted private businesses to invest in the New and Renewable Energy (NRE) field. To strengthen growth potential and encourage the participation of private businesses in the Green Growth Strategy, tax incentives were planned and industrial regulations for 'green' companies were simplified. Private investments in green businesses had a positive impact on reducing GHG emissions. Some of the key priorities underpinning Korea's development of its green economy include the following:

- Introduction of a national carbon emissions trading system.
- Extending public assistance and encouraging investment in 'green enterprises'.
- Public credit guarantees for green technology and green industry sectors.
- Tax incentives for emissions reduction, energy efficiency. and green economy-related initiatives.
- Long-term, low interest green bonds and savings.
- Creation of a green fund to facilitate access to credit for SMEs.
- Mobilizing investment from pension schemes.
- Launch of a green private equity fund.
- Incentives to increase the use of solar energy in households and small buildings.
- Adoption of a Renewable Portfolio Standard, from 2012, requiring a proportion of energy supply to come from NRE sources, with the proportion increasing annually up to 10 percent by 2022.

Source: http://www.greengrowthknowledge.org/case-studies/green-growth-policy-korea-case-study and https://www.cbd.int/financial/privatesector/unep-financial-policy.pdf

The PEPA's legislative gaps regarding the implementation of environmental taxes should be addressed to make it an effective pollution management tool. Clear mechanisms for the adoption of environmental taxes, based on impact studies and in consultation with stakeholders, will need to be put in place. The 'polluter pays' principle will also need to be sustained through secondary legislation and mechanism to ensure that polluters are the ones who cover the environmental costs. The power to design and enforce penalties will also need further clarification of authority and devolution to the provincial level as needed. Taxes could help create an environment fund that could be used to help with investments to move in a greener direction. Federal-level guidelines for a use-based system for classification of water bodies is essential as the point of departure for these systems. Approaches used internationally are usually based on the concept of beneficial uses such as irrigation, fish breeding and capture, drinking water supply, and recreation. A first step toward this type of scenario is the recently approved National Water Policy.

Box 7. The China-Pakistan Economic Corridor (CPEC)

The China-Pakistan Economic Corridor (CPEC) is a key driver to improve environmental monitoring, strengthen institutions, deepen environmental devolution, ensure coordination, green investments, and promote public participation and disclosure. Pakistan needs to generate a boost to growth through increased investments and regional connectivity. In this context, the CPEC appears as a key instrument to drive growth. The CPEC is one of the five corridors under China's 'Belt and Road Initiative' framework of regional connectivity. Both China and Pakistan define CPEC as part of a regional economic connectivity initiative that will not only connect China and Pakistan but will have future links with Iran, Afghanistan, India, the Central Asian Republics, and the broader region. There are four components of CPEC: Gwadar port development, regional transportation and connectivity, power generation and transmission, and co-manufacturing and job creation. The CPEC projects will be located throughout Pakistan, including in some of the most vulnerable and impoverished districts of Balochistan, southern KP, southern Punjab, and northern Sindh.

Pakistan sees the CPEC as a game-changer for uplifting its economy through more trade and jobs and greater foreign direct investment flows from China and other countries. The share of China's investment—roughly US$35 billion—is expected to go to energy projects: coal, solar, hydroelectric, liquefied natural gas, and power transmission. Twenty-one new projects are expected to generate nearly 17,000 MW of energy, nearly doubling Pakistan's installed capacity. Of those 21 projects, Pakistan expects 14 'early harvest' projects to add 10,400 MW to the national grid by 2018. To take advantage of new infrastructure and power capacity, the Government has identified more than 40 sites for new and upgraded industrial parks and special economic zones, designed to encourage investment and boost local employment.
In the context of what could be a dramatic change of investments and growth for the country, strengthening environmental governance and green investments in Pakistan becomes a priority. The CPEC's environmental footprint could be significant under the 'business as usual' scenario, aggravating poverty and putting the basis of natural capital under risk if key policy choices are not designed and implemented effectively.
Source: World Bank.

Harnessing the power of public pressure. Harnessing the power of public opinion by allowing better access to environmental data is a key measure to be achieved though the disclosure of pollution data to engage citizens and encourage preventive actions, effectively engaging with local communities and relevant stakeholders in the city development planning processes, and education and raising awareness to empower citizens. Experience illustrates that pressure from the public has often been a key factor in pushing polluters and regulators to improve environmental management. Pressure from citizens, especially those in the rapidly expanding middle class, has been a major driving force for change in tackling pollution in various countries, such as China. In 2013, for example, citizen outrage over Beijing's hazardous air quality forced the central government to act (Bangladesh Country Environmental Analysis, 2018).

Pakistan could strengthen EPDs' capacity to disclose environmental information and engage citizens in environmental management through: (i) the timely disclosure of environmental monitoring data online and through other channels (such as TV, newspapers, and radio) in both English and Urdu; (ii) the annual public consultation on, and publication of, a report on the state of environment in both English and Urdu; (iii) the strengthening of existing citizen feedback and grievance redress schemes (for example, telephone hotlines and an interactive Internet portal); and (iv) awareness campaigns on pollution management and green development.

Education and raising awareness on the value of the environment and its function in an urban setting are critical for effective citizen engagement. It is important to make urban communities, including school children, more aware of the value of natural resources, including wetlands and their functions in urban settings, and stress the importance of protecting and

managing them. To this end, EPDs should organize activities, such as developing and disseminating various educational materials on environment and management, and information on what citizens can do.

Table 1 summarizes the key policy choices described in this section and includes a number of potential measures that could help operationalize them in the short, medium and long term.[8]

Table 1. Key Policy Choices

Key choices for healthy and productive citizens	Short term	Medium to long term
Key measure 1: Improving significantly environmental monitoring by EPAs and local governments in a coordinated manner among provinces and the federal government		
• EPDs to build capacity for AQM/WQM planning with appropriate equipment, labs, analytics, human resources, protocols, and sustainability.	X	
• EPDs, in coordination with sector departments and local governments, to identify major sources of emissions.	X	
• EPDs, in coordination with cities, to implement a network of air and water quality monitoring equipment.	X	
• EPDs, in coordination with local governments, to supplement capacity for pollution management by partnering with universities and research institutions.	X	
• EPDs, in coordination with PK-EPA and relevant stakeholders, to set realistic AQM/WQM standards with credible compliance plans.		X
• Provincial governments to transfer pollution management capacity to local governments to optimize coordination at the airshed and watershed levels.		X
Key measure 2: Deepening the devolution of environment distinguishing among federal, provincial, and local roles and responsibilities		
• Provincial governments, in coordination with local governments, to clarify mandates in environmental and pollution management in cities with an airshed and watershed management approach.		X
• Planning and Development (P&D) departments to integrate environmental aspects into provincial MTDFs and ADPs.	X	
• EPAs to revise and enforce Provincial Environmental Protection Acts after extensive consultations with stakeholders (PK-EPA, provincial sectors, cities, private sector, citizens, and nongovernmental organizations).	X	X
Key measure 3: Coordinating for better environmental management among the federal, provincial, and local levels and among sectors		
• PK-EPA and provincial EPDs to optimize existing coordination mechanisms (such as the Pakistan Environmental Council or the Council for Common Interest).	X	
• PK-EPA, provincial EPDs, and local governments to establish coordination mechanisms for pollution management at the airshed and watershed levels.		X
Key measure 4: Greening future investments		
• P&D Department, Secretaries of Finance and sector departments to ensure and diversify financing for cost-effective green investments at the subnational level (low-cost, 'no-regret', short-term measures).[9]	X	

[8] For this document, short-team measures are those that could be adopted in the next 4/5 years as part of the new government cycle. Medium- and long-term measures could deepen the impacts of the short-term measures at could be initiated at the same time, when relevant.

[9] As part of this policy choice, Pakistan would need to scale up its investments in WASH to 1.63 percent of GDP if it is to meet the SDGs. Pakistan's total costs of achieving basic universal coverage stands at US$636 million, whereas to reach SDG targets 6.1 and 6.2 for access to water and sanitation, investments of US$4,331 million would be needed. That is

Key choices for healthy and productive citizens	Short term	Medium to long term
• P&D Department and Secretaries of Finance, in coordination with EDPs and sector departments, to leverage economic instruments for environmental protection. Introduce market-based instruments for AQM/WQM.		X
• P&D Department and Secretaries of Finance to promote green investments: facilitate the access to green financing through the adoption of Green Banking Guidelines, credit risks guarantee for SMEs, PPPs for environmental infrastructure, and green bonds.		X
Key measure 5: Harnessing the power of public pressure		
• EPDs and local governments to disclose pollution data to engage citizens and encourage preventive actions.	X	
• EPDs and local governments to effectively engage local communities and relevant stakeholders in city development planning processes.	X	
• Government in different levels to promote education and awareness raising to empower citizens.		X

equivalent to a move from 0.24 percent of GDP to 1.63 percent of GDP. Pakistan will need to use budgetary resources to finance WASH strategically, while also addressing the need to encourage water re-use and rationalizing water supply. Improving collection rates is essential for proper maintenance of water supply and sanitation infrastructure. For effective waste water management in cities, local authorities will also require equipment, training, and technical support. Furthermore, wastewater reuse offers some opportunities for income generation by engaging the private sector through PPPs. To use PPP, particularly with regards to drinking water, there will be a need for programs aimed at creating buy-in from both the private sector and the public, as there is little trust in the quality of piped water. Furthermore, any investments towards WASH infrastructure should include thorough O&M arrangements, since poor sustainability translates into increased public frustration and a reduced perception of confidence of citizens in government entities.

CHAPTER 2: MANAGING LAND AND WATER SUSTAINABLY: THE AGRICULTURE-WATER NEXUS

Agriculture is by far the largest user of water in Pakistan (more than 90 percent of withdrawals) and the expansion of irrigation (both canal and groundwater) has supported growth in agricultural production since independence. This has brought significant benefits for food security and development. Today, growth in the agriculture sector is lower than in other sectors of the economy. This partly reflects a transition toward a more highly skilled, modern, and productive economy (albeit at an uneven and slow pace), but agricultural productivity is characterized by little technical change and instead the intensification of input use. Water use is wasteful by any standard, with governance issues that hamper its efficient use (for example, weak incentives for saving water and improving on-farm water efficiency), overall low economic productivity (around US$1 per cubic meter, one of the lowest values in the world) (World Bank, 2018b), and concerns regarding environmental sustainability (for example, depletion and salinization of groundwater aquifers). Given the current withdrawal levels (around 59 percent of renewable supply, adjusting for surface/groundwater double counting),[10] there is little scope to augment and complement water sources. In addition, the current irrigation system has limited buffer capacity, both in infrastructure and planning ability, making Pakistan (and the agriculture sector in particular) highly vulnerable to any supply shock. Furthermore, demand from other sectors (municipalities and industry) is rapidly growing.

Climate change will make matters worse, pushing up water requirements from crops and livestock, with supply becoming more erratic and less predictable. This makes the sector one of the top adaptation priorities for Pakistan. Given its current low level, there is significant potential to improve water productivity in the agriculture sector, both technically (achieving more efficiency) and economically (orienting water toward higher-value uses). This section highlights a few policy and institutional reforms that could support an overhaul in the sector toward productivity, sustainability, and resilience, around better irrigation service delivery and better on-farm water management, improvements to boost productivity, and better risk mitigation.[11]

2.1 CURRENT CHALLENGES TO THE AGRICULTURE SECTOR

Agriculture remains a critical component of Pakistan's economy and the main livelihood of most of the country's population. Although the contribution of the sector to GDP is only half of what it was 50 years ago, it still has an influence on overall growth performance due to its strong links with industry (for example, cotton for textiles, nonorganic fertilizers). The sector generates nearly one-quarter of GDP, is the largest employer in the country (just above 40 percent of labor force) (World Bank, 2018b), and is directly and indirectly the main source of income for

[10] Risk of double counting arises when surface water and groundwater are not independent (i.e., percolation of irrigation water contributes to recharging groundwater aquifers, which are pumped to provide irrigation water).

[11] For a recent and in-depth analysis (which also looks beyond the agriculture-water nexus), see *Pakistan Water Security Diagnostic* (World Bank, 2018a).

two-thirds of the rural population (SDPI and PRISE, 2015). The sector also accounts for more than 80 percent of export revenue, through agri-food products and agri-based textiles (the largest industrial sector in Pakistan, generating 60 percent of exports in value) (GoP, 2018). Food crops (wheat, rice, sorghum, pearl millet, maize, and barley) account for the largest crop area (13.96 million ha); followed by cash crops (sugarcane, cotton, tobacco, jute, sugarbeet, and guarseed) sown over 4.36 million ha; pulses (1.15 million ha); and edible oilseeds (0.57 million ha). Although the area under cash crops is almost one-third of the area under food crops, production (in tons) (GoP, 2016) in the former is nearly twice that in the latter and the value is almost on a par (Spielman et al., 2016).

The top user of water (90 percent of withdrawal), agriculture is heavily dependent on irrigation. The Indus Basin Irrigation System (IBIS), the largest contiguous irrigation system in the world, is making agricultural activities possible in many locations otherwise classified as arid or semi-arid, with low and variable rainfall. A 50 percent increase in withdrawal for irrigation over 1960 to 2000[12] supported the expansion of the crop area (35 percent increase in irrigated land) and related production (Randhawa, 2002). Today, more than 90 percent of agricultural production is concentrated on irrigated land, which represents 80 percent of cultivated land (Yu et al., 2013). Cropping accounts for about 7 percent of GDP and the top four water-thirsty crops[13] (80 percent of water use) represent together less than 5 percent of GDP. Livestock production, present in all agro-ecozones and particularly in predominantly rainfed regions, is also critical for rural livelihoods and generates about half of the agriculture value-added (CIAT and World Bank, 2017). Agricultural production exhibits a high volatility (standard deviation of growth rate of value-added roughly equal to the mean) (World Bank, 2018b), revealing its vulnerability to climate variability (despite the backing of irrigation) and to market fluctuations.

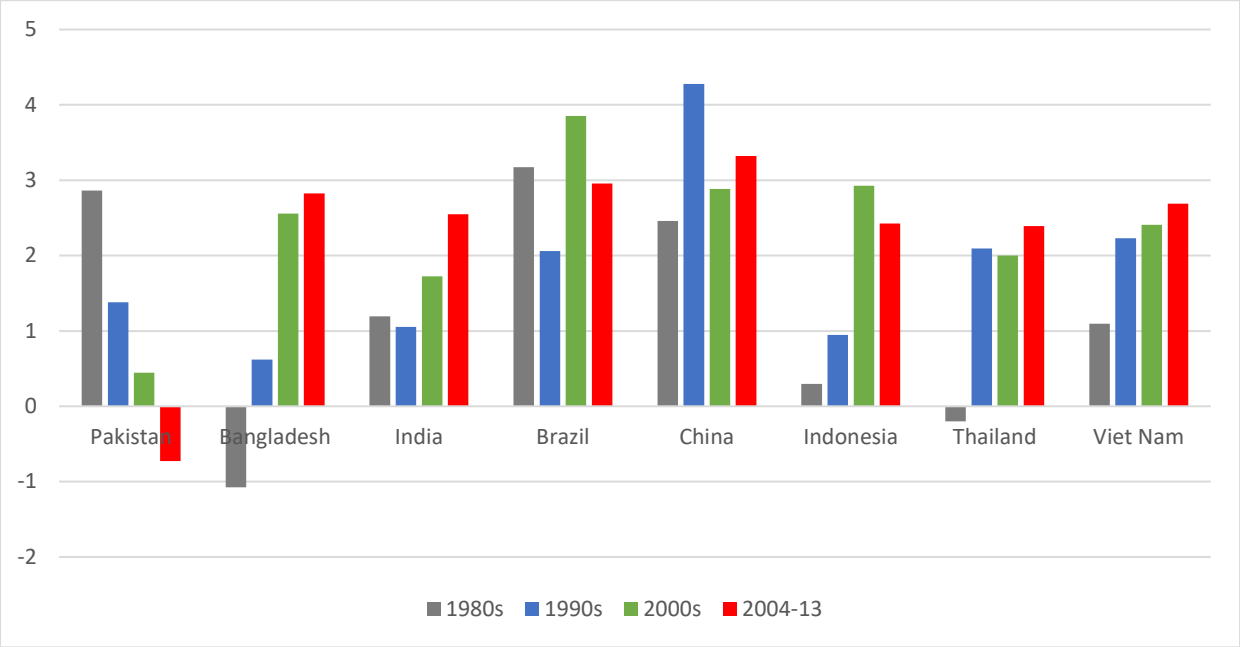
Slowing Growth

Over the past 50 years, the agriculture sector's growth rate has progressively declined, from an average 4.5 percent a year to 2.5 percent a year. Historically, agriculture has played a central role in national development, food security, and poverty reduction, but growth in the sector has slowed for nearly three decades (Figure 10). In comparison to the rest of the economy, growth rates have been lagging since the early 1980s, at 3.4 percent per year in the period from 1980 to 2017, well below those in the industry or services sectors or for the economy as a whole, at 5.5 percent, 5.3 percent, and 4.7 percent a year, respectively, over the same period (World Bank, 2018b). While this partly reflects a transition toward a more highly skilled, modern, and productive economy (albeit at an uneven and slow pace), agriculture is characterized by an inefficient crop mix and overuse of resources such as water. Malik et al. (2016) found that growth in the sector has been largely driven by the increase in input use rather than technical change. This is now exhibiting a downward trend, having demonstrated highest growth rates during the second half of the 1960s (when improved rice and wheat cultivars were introduced on irrigated land during the Green Revolution) and now experiencing historically low growth rates (revealing intensification in input use, often associated with resource-use inefficiency and environmental degradation). Whereas in the 1980s, Pakistan led the subcontinent in Total Factor Productivity

[12] First surface water—through large civil works like the Mangla and Tarbela dams built over the period 1960 to 1975, and later on, groundwater—through exponential growth in tube wells from the mid-1970s onward.
[13] Cotton, rice, sugarcane, and wheat.

(TFP) growth, TFP growth became increasingly only a small fraction of that in other countries and even turned negative (Figure 10).

Figure 10. Annual Growth in Total Agricultural Factor Productivity (Average Annual Growth Rate per Decade, In Percent)



Source: Based on "Agriculture Total Factor Productivity Indices for Individual Countries 1961-2013," USDA (2016); International Agricultural Productivity database, available at https://www.ers.usda.gov/data-products/international-agricultural-productivity/, from World Bank (2018c).

Low growth in the agriculture sector, combined with Pakistan's population growth, raises concerns for future food security. Pakistan ranks among the bottom one-third of countries surveyed by the Global Food Security Index (77 out of 113), with marginal improvements over the past few years. The index highlights issues with food quality and safety, as well as challenges in R&D in the sector (Global Food Security Index, 2017). Without reform and investment, high population growth coupled with low agricultural growth could lead to food availability concerns. There are projections of a shortfall in grains of 5 million metric tons by 2030 (Kirby et al., 2017). Responding to the challenge of food security under population growth and climate change will require adopting a portfolio of options, in which smarter water use is a core dimension. The Task Force on Food Security (2009) recommended that Pakistan's agriculture sector achieve an annual growth rate in agriculture of 4 percent per year between 2010 and 2020 to address the food security needs of Pakistanis. It also called for improving water efficiency through actions such as the promotion of water-saving technologies such as drip and sprinkler irrigation, improving access to credit, and strengthening income support safety nets for very poor households (Planning Commission, 2009).

Lackluster growth in agriculture reflects many challenges, primarily low farm-level productivity, resulting in: high unitary production costs; distortion in prices and incentives of inputs and outputs, causing misallocation of resources and misaligned cropping patterns; and unsustainable use of natural resources, particularly water. The sector also suffers from overall

low levels of public and private investments, resulting in a low technology and capacity environment (for example, with an underperforming research and extension system) and the under-provision of infrastructure (for example, irrigation network in dire need of overhaul, lack of transport and storage facilities, and limited agro-processing to transform raw product and increase value addition and job quality in rural areas).[14] These challenges, which keep the sector far from its production frontier, are the same as those that contribute to increasing its vulnerability to climate change and constrain its adaptive capacity, indicating the clear potential for 'no-regret' adaptation measures that can boost productivity and build climate resilience in parallel.

Low Farm-Level Productivity

Farm-level productivity is well below global and regional levels. In a recent survey, Aslam (2016) concluded that average yields for major food or cash crops (wheat, cotton, rice, maize, and sugarcane) reach only between 18 and 47 percent of international best practices. As for livestock, production growth is associated with increasing animal numbers rather than productivity gains. Low yields translate into high unitary production costs and correspondingly low farm incomes, preventing farmers from investing in better inputs, modern machinery, and land improvements and trapping many into poverty.

The low performance of the AIS seriously constrains farm-level productivity. Limited access to quality, certified seeds is just one example (Box 8). The number of agriculture researchers available per 100,000 farmers is higher in Pakistan than anywhere else in South Asia and this number has increased slightly over the past few years.[15] However, in comparison to neighboring countries, the share of PhD-qualified researchers is lower.[16] Research funding is limited and largely spent on salaries and allowances—overall spending, both capital and recurrent, is only around 0.2 percent of agricultural GDP, which is well below that for other countries in the region.[17] More critically, there is a lack of strategy and direction in setting research priorities; cooperation across provinces, internationally, and with the private sector; and managing and incentivizing staff. Scientists often publish in non-certified journals and the opportunities for training to sustain and expand capacity are limited. Management committees and structures tend to be dominated by government staff who often do not share the same concerns as private sector research nor farmers' priorities. Moreover, the focus is mainly on major crops, with little consideration for horticulture and vegetables, which have the potential for higher value addition and, at the farm level, not dedicating sufficient attention to value-chain development nor to agricultural economics and policy issues.[18]

---

[14] For instance, there are estimates that 50 percent of output is wasted because of the unavailability of a cold chain or the lack of adequate logistics for harvest extraction and processing. Pakistan Business Council. 2018. "Chronic Agricultural Weakness". Dated: January 25, 2018.

[15] Bangladesh: 6.56 researchers per 100,00 farmers; India: 4.62 researchers per 100,00 farmers; Pakistan: 14.43 researchers per 100,00 farmers. *Source:* ASTI (Agricultural Science and Technology Indicators), data for 2012 except 2014 for India.

[16] Bangladesh: 35 percent researchers with PhD; India: 73 percent researchers with PhD; Pakistan: 21 percent researchers with PhD. *Source:* ASTI, data for 2012 except 2014 for India.

[17] Bangladesh: 0.37 percent of agriculture GDP; India: 0.30 percent of agriculture GDP; Pakistan: 0.18 percent of agriculture GDP. *Source:* ASTI, data for 2012 except 2014 for India.

[18] For a review of the Agricultural and Livestock Innovation System in Punjab, see Byerlee et al. (2018).

Box 8. Low Availability of Certified Seeds in Pakistan

Examining the architecture of the Pakistani seed system, in detail, Rana et al. (2016) report that certified seeds represent only about 20 percent of the total seed market, with significant variations among crops (cotton: 12 percent, wheat: 28 percent, maize: 44 percent, and two notable exceptions, rice:116 percent and vegetables: 107 percent),[a] while the rest of the seed requirement is supplied from farmer-saved seed and uncertified seed. In addition, the authors found that breeding activities were focusing on a small set of crops, with cotton and wheat accounting for 40 percent of all cultivars released so far, forcing farmers to rely on unimproved cultivars for other crops. Among the key constraints for companies engaged in cultivar development and seed provision in Pakistan, the authors identify the limited access to material from public sector research institutes for companies that multiply and market public varieties or use public germplasm in their breeding programs, the relatively small size of the market (even more so given barriers to seed trade with India), deficient legislation and enforcement for intellectual property right protection and, above all, the inadequate legislative and institutional framework governing Pakistan's seed system.

Note: a. This means that either the total seed requirement for rice and vegetables is more than the official source estimate or that some certified seed remains unused.

Another factor is the small size of most farms in Pakistan[19] (and persistent rural poverty), which further limits the ability of farmers to take risks (for example, pilot new crops or adopt new practices and technologies) and minimal asset ownership and lack of collateral, which restricts access to credit. In addition, land tenure insecurity is not likely to encourage farmers to invest in land (or other fixed asset) improvement. Overall, smallholder farmers thus lack access to the latest technologies and farming practices, machinery, fertilizer, and seeds that are necessary to improve on-farm productivity and diversify production toward higher-value crops. The penetration rate of modern agriculture technologies remains low even though their potential to increase land productivity is well-established.[20]

Distortion in Prices and Incentives of Inputs and Outputs

There has been a long history of state intervention in the agriculture market and trade policies, including administered prices or protective trade policies, with the objective of supporting food security, income generation for growers, and affordability for consumers. Most of these have been phased out through the 1990s, leaving in effect wheat (through domestic procurement, temporary import/export control, and subsidized sales to select flour mills) and sugarcane (through import tariffs, as well as support prices and export subsidies) as the two major crops with public intervention, while there remain import tariffs and other restrictions protecting dairy products and vegetable oils. In addition, input subsidies (on fertilizers, electricity

[19] In 2010, farms under 5 acres made up only 19 percent of the farm area, while on the other hand, farms larger than 50 acres (slightly more than 1 percent of farms, in number) accounted for 21 percent of farm area. Between 1960 and 2010, the proportion of farms under 5 acres increased from 19 to 65 percent, mostly resulting from the fragmentation of medium-size landholdings (that is, between 5 and 25 acres). Intensifying fragmentation among smaller-size landholdings is reflective of land tenure inequality (as smaller owners, because of their poor economic status, are not able to protect the size of their holdings and are forced to divide their land plots by following inheritance laws) and further accentuating them (as fragmentation is leading to farms of more and more precarious economic viability). Nearly 92 percent of the rural households in Pakistan are "landless or less than 5 acres of land operated," with nearly 95 percent of households in this category classified as poor. *Source:* Malik et al. (2016).

[20] For instance, laser land leveling results in 20 percent increase in crop yield (Gill and Awan, 2009) and zero tillage causes 12 to 15 percent increase in crop yield (Gill et al., 2002; Ahmad, 2009).

for water pumping,[21] or implicitly, on canal irrigation water), though of a lower magnitude (accounting for about 5 percent or less of the value of production), also influence farmers' decisions.

Such interventions have a number of side effects. They incur a high fiscal costs and welfare burdens, while public resources could be allocated to other uses and social concerns could be addressed by other, more targeted, interventions. Interventions additionally distort cropping decisions, resulting in excess production of some crops and not providing incentives for investing in high-value agriculture and post-harvest value addition; and they promote excessive or imbalanced input use (for example, water or fertilizers), with negative externalities and implications for sustainability. In Punjab alone, subsidies to agriculture amount to nearly US$1.25 billion annually, because of wheat, fertilizers, electricity, credit, and irrigation maintenance and repair (M&R) (World Bank, 2018c). About 40 percent is paid by the Government of Punjab, representing about 2.5 times the regular annual investment allocation for agriculture in the provincial Annual Development Program.

Not all subsidies reach farmers (let alone smallholders), as a substantial share of fertilizer subsidies benefits fertilizer companies and the largest share of wheat subsidies benefits banks. Wheat subsidies are embodied in the wheat price, which is basically governed by the procurement price set much above import parity, hurting most urban and rural households, which are net buyers (see Box 9). At the national level, Dorosh et al. (2016), reviewing agricultural prices and trade policies in Pakistan, report that overall, trade protection policies have resulted in implicit taxation for most major crops (wheat, cotton, basmati and International Rice Research Institute rice, and maize). The authors also estimate that large farmers and mill owners are the prime beneficiaries of subsidies on procurement and government sales in the wheat sector. As for the impact of pricing policies on intra-crop incentives, changes in the mix of cotton and sugarcane output is a good illustration, as examined by BIPP (2016). In recent years, the support price of sugarcane has been set higher than the import parity price, which has induced a switch to greater acreage under sugar, including some at the cost of cotton. This can raise concerns both from an environmental sustainability perspective, because sugarcane is more water intensive than cotton, and from an economic perspective, because cotton is an important input for the textile export industry. In addition, the country now has surplus sugar that can only be exported at a loss.

[21] Fuel for groundwater pumping is not subsidized, making power subsidies in agriculture regressive because most electrical wells are owned by larger farmers.

Box 9. The Cost of The Wheat Market in Pakistan

The Government's wheat procurement system in Pakistan, consisting of provincial wheat procurement drives in Punjab, Sindh, and KP, and the federal wheat procurement drive by the Pakistan Agricultural Storage and Services Corporation (PASSCO), each year buys about half of the marketed wheat surplus, equivalent to about 25 to 30 percent of total wheat production, at the so-called support price, which significantly (40 to 60 percent) exceeds world market prices. The support price for wheat has been consistently rising over time.

The high procurement price has resulted in the production of wheat far in excess of domestic needs, an import tariff of 60 percent on imported wheat to ensure that the Government is able to sell the wheat procured; urban consumers and the rural poor (who are net consumers of wheat) paying significantly higher prices than they would in a liberalized wheat market; and huge government stocks of wheat (estimated at least 7 million tons), well above requirements. Efforts to export some of the excess government stocks of wheat have largely been unsuccessful, despite substantial export subsidies.

The wheat procurement system, introduced in the late 1950s, has been evaluated several times by national and international agencies and found to be ineffective in meeting its goals of supporting poor farmers, stabilizing prices, and providing cheap flour to urban consumers. The system is plagued with patronage and rent-seeking, particularly in the distribution of gunny bags, during delivery of wheat to the purchase points, and in releases to flour mills. Small farmers rarely receive bags and face difficulties in accessing delivery points, whereas releases of wheat to flour mills is often not transparent. The system also has enormous costs. The direct costs of buying, storing, and releasing wheat at a fixed price each year are estimated at PKR 62 billion per year, of which more than 90 percent consists of interest payments both on current borrowing and accumulated debt. The direct cost of the wheat subsidy program now exceeds PKR 8,500 per metric ton. The indirect costs are also substantial and include physical losses due to poor storage and high spoilage, pilferage, overproduction of wheat and a consequent underproduction of other higher-value commodities, diversion of credit from the banking system, and a disincentive to the private sector for building storage facilities that would also be available for other crops besides wheat. Market transactions to procure wheat are funded through bank borrowing every year at the prevailing interest rate. Given that these borrowings are not retired through the revenues generated from the collateral stocks of wheat, wheat debts of the provinces to the State Bank of Pakistan now exceed PKR 400 billion.

Source: World Bank Estimates.

Unsustainable Management of Natural Resources, Particularly Water

Finally, agricultural production is negatively affected by unsustainable management of key natural resources, particularly water. Underinvestment (for example, ageing surface irrigation network or no modern monitoring system) and weak governance (for example, unequal access, mistrust in nontransparent and poor-performing institutions, and lack of regulatory framework on groundwater)[22] are leading to a water management crisis, which will worsen with population growth, economic growth in nonagricultural sectors, and climate change. Water productivity in economic terms in Pakistan is below US$1 per cubic meter (data for 2008), comparably lower than other developing economies where agriculture is also the largest source of water abstraction (understood here as above 80 percent of total freshwater withdrawal annually), such as India's US$2.6 per cubic meter (data for 2010), Egypt's US$3.0 per cubic meter (data for 2010), or Morocco's US$9.0 per cubic meter (data for 2010) (World Bank, 2018b). Given its current level, there is significant potential to improve water productivity in the agriculture

[22] Lack of regulation of groundwater resources (a significant supplemental irrigation source) has led to their overexploitation, raising concerns on their recharge and salinity. There are now around 1 million tube wells, corresponding to about half the water use at farm level (Ahmad, 2017).

sector, both in technical terms (achieving more efficiency) and economic terms (orienting water toward higher-value uses).

At present, irrigation water tariffs (*abiana*) are set too low to cover the costs of M&R of canal irrigation management and distribution systems (including drainage).[23] There are inadequacies in how areas are assessed for water tariffs and tariff collection is uneven, inefficient, and inequitable. Irrigation service delivery by the public sector is generally poor, with concerns on the equity and reliability of water distribution. Farmers in the tail end of the canals invariably do not receive their share of water due to the poor physical state of the canals, water theft by farmers upstream, and rent-seeking by operators. Tail-enders are typically deemed to be at a disadvantage, receiving less than one-third of the water compared with farmers at the head of the canals, while paying 30 times more for water access than farmers located at the head of the canals (World Bank, 2018a). In Punjab, for instance (which accounts for 80 percent of Pakistan's agricultural production, virtually all on irrigated land), *abiana* recovered has been decreasing consistently over the years and currently corresponds to 10 to 15 percent of the basic M&R costs required annually. As a result, the gap between collected *abiana* and M&R is currently about PKR 6 billion, with a backlog in deferred maintenance conservatively estimated at PKR 500 billion. This situation is because of several compounding factors, including; (i) extremely low rates (0.2 percent of crop budget), which have not been adjusted for over a decade; (ii) the gap in *abiana* assessment, where it is estimated that the assessment by the Punjab Irrigation Department (the base for fee collection) represents only half of the actual crop area; and (iii) the uneven recovery rate, which reflects user dissatisfaction with irrigation service delivery and a lack of effort by department staff. In addition, *abiana* are now charged (since 2003/04) on the basis of a flat rate per hectare, making farmers insensitive to water saving and efficiency. Similarly, the gap between operation and maintenance expenditures and revenue collection is about 70 percent in Sindh. KP and Balochistan achieve a higher recovery rate of operating costs (40 to 60 percent), largely because of the far smaller extent of irrigation schemes in these provinces (World Bank, 2018a). This funding gap is also putting a major burden on the provinces' fiscal space.

Land degradation is also adversely affecting agricultural production and improper water use and management is a major cause of land degradation. There are estimates that about 40 percent of irrigated land has been affected by either salinity or waterlogging (primarily in Sindh, then Punjab)[24] and that salinity alone represents 60 percent of the costs to agricultural production of land degradation (World Bank, 2006). Salinity primarily results from over-irrigation (which, in combination with insufficient drainage, also causes waterlogging) and the intrusion of seawater (in Sindh), which makes brackish groundwater saline. Salinization of land and aquifers threatens the fertile Indus Delta, which has lost close to 1 million ha of arable land due to saline intrusion from reduced river flows and rising sea level, and is a major contributor to the current outmigration along the Sindh coast (USAID, 2017). Waterlogging is another environmental problem that degrades land productive potential.[25] Kahlown and Azam (2002)

[23] *Note:* Operation and maintenance costs are even higher as they include over and above M&R costs, salaries of Provincial Irrigation Department staff (thousands of employees) and operations budgets.

[24] Salinity is most serious in Sindh, where about 50 percent of the area is saline. Waterlogging is also prevalent in Sindh, where 60 percent of the irrigated area is severely waterlogged, while about 25 percent of the irrigated area in Punjab is waterlogged (World Bank, 2018a).

[25] Intensification of groundwater use (initially to compensate unreliable canal water supply) was also promoted to combat waterlogging and salinization resulting from high water tables caused by recharge from canal and irrigation schemes (75

reported that the drop in the water table from 1 to 2 m to less than 1 m resulted in yield losses of 27 percent and 33 percent for wheat and sugarcane, respectively. For cotton, a falling water table from 2 to 3 m to less than 1 m caused yield losses of 60 percent. The imbalanced use of pesticides is also leading to environmental degradation. Intensive cultivation and imbalanced use of fertilizers are depleting essential plant nutrients from soil, resulting in low land productivity (Aslam, 2016).

Table 2. Water Demand Scenarios for Pakistan

Sector	Share of total demand (%)				Increase from 2015 levels (%)		
	2015	2050			2050		
		No climate change	Climate change (1°C)	Climate change (3°C)	No climate change	Climate change (1°C)	Climate change (3°C)
Agriculture	86	76	77	77	25	32	42
Rest of the economy	8	17	17	17	217	229	253
Environment	7	6	6	6	27	32	36
Total	100	100	100	100	39	47	58

Source: World Bank, 2018a.

2.2 TRENDS FOR AGRICULTURE PRODUCTION AND WATER DEMAND

Pakistan should be able to manage its water supply-demand balance for many decades to come without supply augmentation but through improved demand management, increased water use efficiency, and enhanced economic productivity of water. Simple projections of water availability and demand indicate that Pakistan will not run dry and should be able to manage its supply-demand balance for many decades to come. The projections assume climate change is not expected to have a significant impact on average water availability. At the same time, demand will grow, driven by population and economic growth. Demand management will be critical to achieving this balance. Importantly, a key driver of increasing water demand will inevitably be rising temperatures, which will increase crop water use, increase urban and industrial demands (including cooling water for thermal power plants), and increase the high natural losses of water in the lower Indus River Basin. Economically, Pakistan will need to make the water available to agriculture 'work harder'—in other words, to generate greater economic returns. This can be achieved with improvements spanning irrigation management, agronomic, crop diversification, value-addition processes, marketing, and distribution.

percent of groundwater used is from canal leakage). This interlinking of use and management of surface and groundwater provides a clear example of conjunctive use that was highly effective until groundwater use exceeded its recharge by a significant margin (such as in Punjab). However, in other areas of the Indus River Basin (such as Sindh), groundwater levels are still rising or steady and even where severe depletion is occurring, water levels in most places are higher than pre-irrigation (World Bank, 2018a).

Box 10. No Significant Change in River Flow Projected Before 2050

There are considerable uncertainties as to the rate and extent of glacier and snow pack melt, as well as on precipitation patterns under a changing climate. All glaciers are expected to retreat. Radic et al. (2014), comparing a range of global circulation models, estimate that the glaciers in the western Himalayas, the Karakoram, and Hindu Kush may lose in the range of 5 to 80 percent and 30 to 85 percent of their mass through this century, depending on climate change intensity. As for precipitation, climate models project positive or negative trends, with the largest variability around the monsoon period (World Bank, 2017b). Analysis at a finer geographical scale (but not considering the full ensemble of climate models) points toward a shift of the monsoon belt toward the northeast, with an increase in summer precipitation within the belt and a corresponding drying up over Punjab, some areas of Sindh, and Balochistan, and toward a decrease in the frequency of intense rainfall events, becoming confined to the monsoon belt and the coastal area of Sindh, and the intensification of rainfall during these days (Ikram et al., 2016).

Combined uncertainties on glacier and snowmelt rates, precipitation patterns (including monsoon regime), and temperature changes make it difficult to assess the impact of climate change on future water runoff in the Indus River Basin and in particular water availability during the summer, growing season, and change in flood risk. Currently, at 40.6 percent, glacier melt is the largest contributor to runoff in the Upper Indus River Basin, followed by rainfall (26.8 percent), snowmelt (21.8 percent), and base flow (10.8 percent). Changes in summer temperature will mostly drive glacier melt, while changes in snow/rainfall balance (which depend on expected precipitation volume and temperature) will mostly influence volume from snowmelt. Overall, the few existing studies (see UNDP [2017b], for a review) conclude that glacial retreat is unlikely to cause significant changes in water availability over the next several decades and that other factors, including groundwater depletion and increasing human water use, could have a greater impact. Beyond the mid-century, significant uncertainties arise given the large uncertainty and variability in the amount and timing of rainfall, which progressively becomes a more important contributor to runoff in the Indus River Basin as glaciers have retreated.

Using a large-scale, high-resolution cryospheric-hydrological model to quantify the impact of climate change on the upstream hydrological regime of large rivers in Asia, Lutz et al. (2014) project an overall increase in runoff in the Upper Indus River Basin, mostly driven by glacier melt, for most of the ensemble members. They report a 7 to 12 percent increase in discharge by mid-century (in reference to mid-2000s) for Representative Concentration Pathway (RCP) 4.5 and 2 to 8 percent for RCP 8.5. There is only a 5 percent decrease in discharge in the warm and dry scenario, resulting from a precipitation decrease. Over the coming decades, this marginal increasing inflow is likely, however, to be offset by higher natural losses and technical demands because of global warming. These findings and conclusions are consistent with those from Yu et al. (2013), who estimate that up to the mid-century, the primary impact of all but the most extreme climate change scenarios could be a shift in the timing of peak runoff and not a major change in annual volume.

Without intervention, water demand is projected to grow significantly over the next 30 years or so, by at least 40 percent (Table 2). Estimates vary, depending on assumptions regarding demographic growth, economic growth, and contribution of different sectors, as well as the magnitude of climate change.[26] Demographic and economic growth are the largest drivers of demand increases across all sectors, in both relative and absolute terms. However, climate change would see additional very significant increases in water demand (chiefly from agriculture), in the absence of attention to demand management. While agriculture continues to represent the bulk of demand, it accounts for only half of the increase from now until mid-century, given rapid growth in demand from other sectors. Climate change is expected to further push water demand across all the economy, with the largest increase in agriculture. Between 16 and 32 percent of the increase in water demand by 2050 could be attributed to climate change, depending on its magnitude. The largest increase (70 to 80 percent of total increase) is due to

[26] For detailed background and analysis of these projections, see Chapter 6 in World Bank, 2018a.

higher water requirements in agriculture,[27] with the remainder due to higher demand from other sectors (for example, cooling for thermal power plants).

In the absence of effective demand-side management, growth in water demand will not be sustainable. Climate change is not expected to have a significant impact on average water availability in the coming decades (see Box 10). At the same time, future demand estimates are approaching the volume of water available in Pakistan. The current withdrawal levels are already nearing 60 percent of renewable water supply, making a 40 to 60 percent increase unsustainable, especially when considering natural system losses (accounting for about one-third of the available water), currently inadequate environmental flows, as well as rising year-on-year variability. It is also unlikely such a surge in demand could even be met with further unsustainable increases in groundwater pumping. The projections in Table 2 do not assume efficiency improvements, which are necessary to balance supply and demand. The water-thirsty, low-productivity development model of the agriculture sector is no longer sustainable. To accommodate growth in other sectors, gain in value addition, and build resilience to ongoing climate change, it is critical for agriculture to improve water management, encourage water efficiency and saving, diversify crops toward higher value-added horticulture, and invest in value chains.

The Additional Stress from Climate Change on Agriculture

Given the warmer temperatures and higher water requirements, more frequent and severe extreme weather events together with sea level rise, average climate change is expected to hit agriculture hard, with concerns for competition over water resources and land fertility, crop failure, and livestock productivity.[28] Pakistan's Intended Nationally Determined Contribution (INDC) highlights current water stress and disaster risk, and identifies agriculture as one priority adaptation area. While rising temperatures could lead to minor yield improvements in the north by extending the growing period, the yield of staple crops, such as wheat, maize, or rice, which are predominantly grown in the south, are projected to decrease by up to 20 percent, resulting in higher food prices and increased food insecurity. Livestock production is predicted to decline by 30 percent in part because rangelands will become increasingly stressed by longer droughts. Salinization of land and aquifers threatens the fertile Indus Delta and sea level rise will aggravate this situation, further contributing to land degradation and loss of fertile soil. Areas of Pakistan considered to be particularly vulnerable to the impacts of climate change include the country's existing arid and hyper-arid areas, the flood-prone lowland areas in Sindh and Punjab provinces, and the coastal areas increasingly at the risk of salt water intrusion.

[27] Warmer temperatures, particularly in summer, are expected to increase evapotranspiration, pushing up water demand from crop and reducing soil moisture. Beyond influencing water use and demand, warmer temperatures will have other impacts on plant phenology. Higher night temperatures are expected to increase respiration, lowering crop yield. Sudden shoot up of air temperatures in early spring when wheat and other winter crops are at reproductive stage might cause significant reductions in yield despite no apparent effect on the health of the crops (Rasul et al., 2011). Farmers that grow fruits and vegetables are already experiencing the impact of warmer temperatures, shortening spring considerably and impacting yields with fruits ripening early without much time for growth (Source: "Shorter, hotter, earlier: Shrinking spring slashes Pakistani harvests", Thomson Reuters Foundation, May 21, 2018). Livestock is also expected to be vulnerable, owing to heat stress and productivity of pastures (or fodder production).

[28] For a review of climate change impacts on agriculture, see SDPI and PRISE (2015), UNDP (2017b), and World Bank (2016).

Box 11. Climate Change: Where Is Pakistan Heading?

The mean annual temperature over the country rose by 0.57°C through the 20th century, with a faster increase in the beginning of the 21st century. There is now one more month of heatwave days, sometimes with devastating consequences, such as the 2015 heatwave in Karachi, which took the lives of over 1,200 people. The cryosphere in the mountainous areas is retreating, increasing the risk of landslide and flooding in these regions; and sea level is rising, accelerating costal erosion, increasing the frequency and severity of storm surge and flooding, and causing salination of surface and groundwater. Extreme weather events have also grown in severity, with high human and economic costs. Climate change will intensify, with the mean annual temperature rising by 1–3°C around 2050 and 3–6°C around 2100, depending on global efforts to curb GHG emissions, and the sea level rising by a further 60 cm at the end of the century. Water availability is also expected to become more variable, given enhanced glacier melt, more erratic precipitation patterns, and more prevalent weather extremes, while demand for water is expected to grow, given the higher evaporation rates and demographic and economic growth. Moreover, droughts, floods, and heatwaves are anticipated to gain in severity. Climate change impacts will be felt across all sectors and regions, and will slow down economic growth. Even low levels of climate change could cost the economy up to 1 percent of GDP annually by mid-century. Climate change will also have profound implications on living standards, with Sindh and Punjab at the forefront (Mani et al., 2018), and make it harder to eradicate poverty, potentially pushing up to 21.4 million additional people into poverty by 2050 (see PK@100 Policy Note on Inclusion).

Climate change impacts on yield and livestock productivity are expected to have negative implications for agriculture. Even low levels of climate change (namely, moderate temperature increase and relatively stable water availability, or what could be expected until mid-century) could cost the economy up to 1 percent GDP. In addition, the impacts of climate change on the agriculture sector have strong repercussions on household incomes (through higher food prices) and on subnational climate vulnerability (with Sindh at the forefront in most cases). Yu et al. (2013) thus estimated that the country's GDP could decline by 1.1 percent for a 1°C rise in temperature and relatively stable water flows. At the same time, the agriculture GDP and household income would contract by 5.1 percent and 2.0 percent, respectively. The reduction in economic activity would become much more significant (2.7 percent drop in GDP) for more intense climate change scenarios, for example, a 4.5°C rise in temperature and decline in river flows (which could prevail in the second half of this century). Losses to agriculture GDP and household income would more than double in this case, to 12.0 and 5.5 percent, respectively. In terms of agriculture production, water-sensitive crops (irrigated rice and sugarcane) would bear the brunt of climate change impacts, with a reduction in production of about 6 percent in the moderate climate change case and over 20 percent in the worst-case scenario. Sindh emerges as the most vulnerable region, where crop production could contract by 10 percent under low levels of climate change and by more than 36 percent in the most extreme climate change future. More recently, Davies et al. (2016) reported that climate change could result in negative impacts for the entire economy, and agriculture in particular, driven mostly by temperature rise and increased evapotranspiration. They found that climate change could lead to annual GDP losses of 0.5 to 1.2 percent by 2050 (and 0.7 to 1.3 percent losses for agriculture production), with larger losses for dryer and warmer climate change scenarios. In terms of subnational climate vulnerability, Sindh and Punjab would bear roughly equal impacts.

Nearly all the recommended adaptation measures for agriculture in Pakistan gravitate around improving water management, reducing wastage, and encouraging water use efficiency and saving. Top adaptation measures include shift to less water-intensive crops, adopt high efficiency irrigation technologies, and encourage water conservation, encourage

rain/floodwater harvesting, and increase storage capacity. There are also specific measures for livestock, such as introducing livestock varieties with higher productivity, while adapting to local conditions.

Analyses of the cost-effectiveness of these measures emphasize the major benefits from more efficient irrigation systems, and more productive and climate-resilient seed varieties. Literature provides some insights, based on econometric approaches (inference based on observations) and integrated modeling and assessment (projections). Dehlavi et al. (2015) estimate, through an econometric approach, the rationale and cost-effectiveness of on-farm adaptation measures for farmers in Punjab and Sindh. They consider five measures, including crop timing, crop choice, input mix, soil conservation, and water conservation. Their findings demonstrate the benefits from adapting to climate change, with potential gains in yields for cotton (52 percent), wheat (49 percent), and negligible gains for rice. They note, however, that their analysis, relying on historical observations, might not adequately address the scope for adaptation to climate change (with continued and more intense warming), especially for climatically stressed crops such as rice.

Yu et al. (2013) examine the scope for adaptation to changing water regimes in agriculture and energy over the next 50 years, through coupled water, energy, and agriculture models. They focus on three broad adaptation categories throughout the Indus River Basin: lining of canals and watercourses (+50 percent irrigation efficiency improvement),[29] increased storage (additional 13 million-acre feet, for irrigation),[30] and investment in agriculture technologies (improved crop yields). The overall findings indicate the major benefits of developing more productive crops and improving irrigation efficiency, while increased storage reduces the impacts from climate change, but does not completely mitigate these.

Zhu et al. (2013) assess a range of climate change adaptation options, including both stronger agricultural productivity growth—through increased development of high-yielding varieties and breeding for heat and drought tolerance traits, for example—and enhanced water-based adaptation measures. They report that a combination of a dramatic improvement in agricultural research (both crops and livestock) and improved irrigation efficiency can achieve the best outcomes for Pakistan under a changing climate. Their analysis also suggests that increasing reservoir storage without considering other adaptation options cannot improve crop productivity and production to the same level (consistent with findings by Yu et al., 2013). This does not necessarily deny the other benefits that more reservoir storage may provide, such as hydropower, flood protection, or controlled release of environmental flows. However, given the social and environmental issues associated with large civil works (for example, reducing the flows to the Arabian Sea, which are already at an environmentally unsustainable low level), rapid rates of reservoir sedimentation, and cheaper and more flexible

[29] Lining of canals and water courses will contribute in reducing conveyance losses, of water that otherwise seeps to the ground and recharges groundwater aquifers. This is particularly relevant in Sindh, where groundwater is saline and thus lost to irrigation; this is less of an issue in Punjab, where water can be pumped back and applied for irrigation (even though there are additional costs of pumping for farmers).

[30] Additional storage might help address intra-annual water availability issue. The bulk of water flows into the Indus River Basin during the summer crop season, approximately five times the flow in the winter season, concentrated over a three-month period. Although this is more than adequate to meet irrigation demand during the summer season, the lack of storage capacity to retain enough water to meet demand or the early part of the winter crop season is a major constraint (World Bank, 2018a).

alternatives that deliver larger benefits (for example, canal lining for irrigation), there is less rationale to justify the costs of major new storages. Hydropower generation may justify new dams, but these could be run-of-the-river facilities (not storage), with lower social and environmental impacts—a view supported by Davies et al. (2016) and World Bank (2018a). Other renewable energy sources might also be viable options that are worth exploring.

2.3 POLICY AND INSTITUTIONAL REFORMS

Water productivity in Pakistan is very low, and reform, investment, and modernization are crucial to improve performance and transform irrigation into a vibrant commercial enterprise. The current water use in agriculture (for irrigation) is technically inefficient due to poorly maintained and operated infrastructure, and widespread use of water-wasting irrigation methods. Water use is also economically inefficient due to distorted policy incentives that encourage water-thirsty crops (especially sugarcane and rice, but also wheat and cotton) at the expense of less water-consuming crops with higher value-added (such as horticulture, oilseeds, and pulses) for which consumer demand is growing. Inadequate and deteriorating drainage infrastructure means that waterlogging and salinity are widespread and worsening. The overall result is low economic productivity of water in agriculture (only 12 countries rank lower). A reduction of the share of agriculture in total water demand requires a comprehensive approach toward simultaneous transformation in the agriculture and water sectors through the introduction of a series of policy reforms, institutional changes, development of an enabling legal framework, and targeted public investments in irrigation infrastructure rehabilitation and improved water governance. Such an approach has thus far been lacking in Pakistan.

Encourage Efficient Water Use

Under its Energy, Water and Food Security Pillar, Pakistan Vision 2025 recognizes the need for policies to correct demand and supply imbalances, and ensure access to adequate supply of water for all. In relation to irrigation, the Vision calls, in particular, for practices and technologies to minimize wastage, promote conservation, and gain efficiencies through rationalization of pricing. Similarly, Pakistan's National Climate Change Policy and its companion framework identify among priority actions for resilience in the water sector, the rehabilitation and upgrading of the country's irrigation infrastructure, reducing losses from the irrigation system, adopting more efficient irrigation techniques, development of (financial) incentives for the adoption of efficient irrigation techniques, and the use of improved irrigation and land management techniques to enhance crop productivity per unit of water. The 2018 National Water Policy also highlights similar areas. Recognizing the objective to achieve water security across several development sectors, the policy specifically identifies priorities for agriculture, such as modernizing irrigation and production systems for water conservation, saving, and efficiency (with a target of 30 percent improvements over the period 2018-30), encouraging more equitable and inclusive irrigation management approaches, revising water pricing, and creating an integrated information system for the planning and development of water resources.

Box 12. Interprovincial Disputes Continue to Dominate the Policy Debate on Water Reforms

The 1991 Water Apportionment Accord defines three distribution patterns for allocating water among the provinces when shortages and surpluses occur. Several ambiguities exist as to what constitutes 'initial conditions' that have created mistrust in the process. The method for estimating water availability is outmoded and depends on correlations with prior irrigation season deliveries. The updating of these estimates, between the Indus River System Authority (IRSA) and the provinces, as the season goes, is not without friction. There are major, ongoing controversies over measuring flows at both the barrages and the heads of the canals that distribute water and lack of a properly operating telemetry system. This has been a serious impediment for years to mediate interprovincial disputes and support water resource management, including the development of new infrastructure. (See International Union for Conservation of Nature [IUCN]-Pakistan [2010]). At the same time, (temporary) flexibility in interprovincial allocation could yield benefits, but again, this would require a trusted monitoring system. From the perspectives of equity, efficiency, and conflict reduction there is a strong case for introducing mechanisms to facilitate a voluntary reassignment of water among users (WSTF, 2012). Provinces could be better off if there were mechanisms whereby some entitlements could be temporarily transferred from one province to another (in exchange for compensatory payments). In other countries, this mechanism has been vital in maximizing output, minimizing conflict, and providing resilience in times of drought. This is for instance established by Yu et al. (2013), who find that relaxing the accord constraint and allowing optimal economic allocation, between and within provinces, would enhance the ability to manage extreme events (for example, droughts) by more reliably meeting systemwide demands. Overall, both Punjab and Sindh provinces stand to gain.

Source: "IRSA to install 24 telemetry systems on Indus River", the Nation, July 3, 2017.

Modernize Water Measurement and Accounting

Water is a limited resource in Pakistan and under increasingly high demand, which makes it imperative to know how much water there is, where it is, how it is being shared, and how it is being used. This is important for managing variability in water supply, tracking and improving water productivity, enhancing trust, and ensuring equity among water users (be it among provinces or among sectors). This would also help develop better understanding of demand (including from other sectors, beyond agriculture) to shift the culture of water management from a supply-constrained focus to a dynamic demand and supply focus. For agriculture, this would provide the much-needed evidence on the actual status of the irrigation system, helping identify hotspots for priority action and assess the benefits of interventions (for example, impact from canal rehabilitation on conveyance losses, support measures for high efficiency irrigation systems, reformed water tariffs, just-in-time information on crop water requirements, and so on).

Mapping Groundwater

It is necessary to expand water monitoring beyond the question of water availability in irrigation canals and surface water bodies. There are vast domains in Pakistan's water resources that are still poorly understood and managed, and on which accurate, up-to-date, and frequently updated data are required to improve knowledge of water resources and their fate under a changing climate and support a move toward their integrated management (in agriculture, and also other sectors, including disaster-risk management [DRM]). Examples include the cryosphere (where glacial and nival regimes control about 60 percent of the Indus River Basin discharge), whose dynamics under a changing climate is poorly understood, as well as groundwater, the quality of which has degraded rapidly, and which is being depleted in some areas.

Groundwater monitoring is urgently needed to guide sustainable resource use. Groundwater is used extensively both in areas without surface water irrigation and to complement surface water irrigation. Expansion of groundwater pumping has been totally unregulated, leading to concerns on its availability and quality (see footnote 25 on water levels and 29 on water salinity). Global experience shows that in areas with unregulated groundwater development, it is difficult to balance abstraction and recharge. Critical conditions for success include: (i) the existence of a regulatory framework that constrains users from overexploitation beyond the aquifer limits; and (ii) government support for groundwater user associations (feasible only for smaller aquifers). In the first instance, the GoP should focus on monitoring groundwater level and fluxes – abstraction and recharge and quality (including pollutants from agriculture, municipal, and industrial waste) and communicating the results to all stakeholders. Better information base on groundwater will be essential to manage this resource (which will be increasingly used as water demand rises), including in terms of conjunctive use with surface irrigation, as well as support formulation and monitoring/implementation of groundwater policies. The 2018 National Water Policy acknowledges the strategic importance of groundwater and encourages provinces "to prepare a Groundwater Atlas for each Canal Command and sub-basin delineating: Groundwater development potential, water quality zones, water table depth zones, and recommendations for installation of different types of tube wells." In the longer run, all wells could be metered and charged for water extraction, provided effective institutional arrangements are defined for monitoring, revenue collection, and enforcement.

Strengthening Mandate for Water Measurement and Water Accounting Across the Indus River Basin

Extending and modernizing the water measurement infrastructure (including data management and sharing) is required and is relatively simple to do from a technological standpoint. Strengthening institutional capacity for improved water governance is critical and much harder to do, and will take some time. Efforts should be oriented towards creating a process for basin-scale water resource planning, in particular for improving inter-provincial water sharing including addressing the changing scales and sectoral patterns of water demands, as well as clarifying the risk-sharing arrangements for periods of extreme scarcity. The Water Apportionment Accord has provided stability around interprovincial water sharing for several decades, but the Accord's arrangements are not optimal nor robust for the range of potential future conditions. Provincial water shares need also to more explicitly recognize the needs of Pakistan's growing urban economy. Strategic basin planning can also support the process for improving efficiency and equity of irrigation water distribution as well as for determining incremental inter-sectoral allocation of water, and support the adoption of conjunctive management of surface and groundwater to improve climate resilience, equity of water access, water use efficiency and water productivity. This will require an overhaul in terms of water data, information, modeling and analysis as well as policy and institutional reforms and capacity building, involving a number of institutions, such as the Water and Power Development Authority (WAPDA) and IRSA, on water data management, modelling and forecasting, including through use of Earth observations, as well as Provinces, especially for monitoring and reporting water distribution and use. The Pakistan Council of Research in Water Resources (PCRWR) could also play a role here, notably around basin-scale modeling and analysis of surface-groundwater interaction.

Reform Irrigation Water Service and Tariffs

Water pricing can be an important tool to encourage water saving and efficient use. Currently, the water price in agriculture does not even cover the operation and maintenance costs of the surface irrigation network (placing a huge burden on public purse), let alone its opportunity cost (e.g., in terms of competition with uses in other sectors, with potentially higher value-added) or the externality associated with the extraction of groundwater and its environmental impact on pollution and environmental degradation (for example, outflows to the delta region). Effective water tariffs (including more even and effective collection) would contribute to mobilizing sufficient funds to end the so-called 'build/neglect/rebuild' cycle and enable consistent investment in an otherwise ageing water infrastructure, improving its technical efficiency (for example, canal lining to reduce conveyance loss), its responsiveness (for example, automation and monitoring for faster and more timely management), and its resilience to growing water variability (for example, increasing storage to cope with flood and drought episodes and accommodate inter-seasonal variability, better matching summer excess and winter demand). Beyond a service fee, which cover the costs of providing the irrigation service, there could be consumptive use charges to incentivize judicious water use, loss reduction, conservation, and the more efficient use of water in agricultural systems, including through the adoption of water-efficient technologies and practices to achieve 'more crop per drop' (for example, drip irrigation, land leveling); or increase water conservation (for example, rain harvesting, no-tillage, or the use of crop residue such as mulch to conserve soil moisture); or shift to crops that are less water-intensive and more drought-tolerant. Effective water tariffs can send the price signal needed to improve irrigation systems and transform agriculture, but they would need to be complemented by other well-designed policies to tackle various market and government failures, including supporting awareness-raising and capacity building, and investing in relevant R&D initiatives and fostering demand and supply for water-efficient technologies and practices. In addition, there is a need to improve water resource management information systems, to know how much water there is, where it is, how it is being shared, and how it is being used.

Improvements are required in assessing the areas for water tariffs, in setting differential tariffs that reflect the level of services provided, and in the efficiency and completeness of tariff collection. There are indications that farmers might be willing to pay more for high-quality service, by comparing costs for pumping water (a year-round reliable supply) to *abiana* rates paid for surface irrigation, which are often 10 times more expensive (WSTF, 2012). Bridging the gap between M&R and *abiana* revenue to move progressively toward cost-recovery to prevent further deterioration of the irrigation system and support its modernization (see Box 13 for an ongoing initiative in Punjab) would require working in parallel on:

- A gradual increase of *abiana* rates over several years. The current rates represent a minimal fraction of the overall production costs of irrigated crops, so recurring increases over several years to bridge the large gap with M&R expenditures should have a minimal impact on farmers. Clear and credible announcements regarding a series of gradual increases in *abiana* over time would also be necessary to manage the transition;
- An improvement to the Irrigation Departments' *abiana* assessment procedures (for example, by using satellite imagery to cross-check assessment by the Irrigation Department staff) to close the gap between the assessments made by the Irrigation Department and the (higher) assessment based on actual areas sown; and

- An improvement in recovery rates (including for arrears), which could be incentivized with arrangements that collected *abiana* payments flow to the provincial Irrigation Departments for the operation and maintenance of the irrigation network and not to the provincial Finance Departments (where they could be allocated to other uses).

Box 13. Leading By Example: Agriculture Reform In Punjab

The US$300 million SMART Program will support Punjab's efforts to modernize its agriculture sector, raise farmers' incomes, give consumers better quality and safer food at lower prices, create jobs on farms and agribusinesses, and improve the use of irrigation water.

More equitable access to water and better assessment and collection of *abiana* would encourage producers to use water more efficiently with no increases in overall water use and increase funds for M&R. The adoption of a Provincial Water Policy and Groundwater Act are important first steps toward addressing the overexploitation of water, falling groundwater tables, and increasing salinization. The SMART Program will, in particular, support the approval of the Punjab Water Policy; the approval of the Groundwater (Protection, Regulation, and Development) Act; improvements in the area assessed for *abiana,* as well as in *abiana* tracking and collection (with the goal to increase *abiana* revenue to PKR 1.8 billion); and improvement in water delivery performance ratio in selected canals (with the objective to bring the delivery performance ratio to 90 percent).

This will contribute to improving the sustainability and efficiency of irrigation through more equitable water distribution, improved financial sustainability of M&R of surface irrigation, and better management of groundwater resources.

Besides increasing *abiana* and improving its collection, additional measures are needed to improve irrigation management, given that the lack of observable improvement in service governance and provision will not lead to higher payments. These measures include the following: (i) continued devolution of M&R to water users under modified model(s) that reduce irrigation management costs and responsibility of the Government; (ii) outsourcing M&R work under performance contracts with the involvement of farmers/water users and their contribution in cash or kind, accompanied by a strong monitoring mechanism that links payments with actual performance; and (iii) allowing farmer organizations to increase *abiana* and collect it in advance within their jurisdictions. While the growing involvement of water user and farmer associations/organizations in irrigation management can result in lower costs for public organizations and greater inclusiveness, this involvement needs to be managed carefully to mitigate the potential impact of elite capture. Research by Jacoby et al. (2018) indicates that water theft increased in channels taken over by local farmer organizations compared with channels that remained bureaucratically managed, leading to substantial wealth redistribution. The increase in water theft was greater along channels with larger landowners situated upstream. For instance, in a companion analysis, Jacoby and Mansuri (2018) conclude that "consistent with a model of misgovernance, the decline in water availability from channel head to tail is accentuated along canals having greater lobbying power at the head than at the tail."

In the longer term, the introduction of volumetric water pricing should be considered, making use of progress in remote sensing technologies. Currently, the actual supply of irrigation water to a given field is crop-dependent (number of applications differs by crop and defines the quantity of water supplied), while *abiana* is charged on an area basis, that is, independent of the actual crop grown. While many efforts to install volumetric measurement devices have failed in the past (farmers tampering with those), innovative technologies might

now allow remote measurement of water consumption (for example, based on evapotranspiration with the help of satellite imagery) for a lower cost and greater confidence in observations. The volumetric pricing of water would greatly improve water use efficiency and increase *abiana* revenues. Coupled with a modernized system to control water distribution (e.g., where farmers can "order" the water they need and only take the water they want), this could allow demand-based management, where just-in-time ordering and delivery would be possible, making irrigation much more efficient than the current *warabandi* system. However, implementation would require proper preparatory work to accompany and support this cultural and technical shift, including the required modifications to the system, such as needed instrumentation, the impact on small farms, and implementation mechanisms.

Improve Land Productivity

A second area for policy and institutional reforms, in the sense of a more productive and resilient agricultural sector, relates to land productivity. Today, price and market interventions keep the sector focused on a few major crops, produced at too high a cost (especially wheat), and away from diversifying to higher value-added crops and investing in post-harvest value addition. In addition, the current policy incentives have significant environmental costs, with implications for sustainability and climate resilience: they encourage, for instance, water-thirsty crops (especially sugarcane and rice, but also wheat and cotton).

Reform Agricultural Subsidies

The number of agricultural subsidies is many times larger than public resources allocated to productive investments for agriculture, as reflected in the Annual Development Programs. Most subsidies are of a regressive nature, generate significant negative environmental externalities, and are nearly exclusively focused on major crops rather than higher value-added agriculture. As a result, over 90 percent of the cropped area in Pakistan remains under major crops (dominated by wheat), while only 5 to 9 percent is planted with higher value-added crops. While these policies serve vested interests making their reform politically sensitive (good examples include the public wheat procurement program, electricity subsidies for tube wells, marketing of crops through archaic *mandis*, low *abiana* rates, and so on), they keep the sector locked in a high-cost/low-return production pattern that results in low incomes for farmers and high prices for consumers.

Now that Pakistan has become a food-secure country and has too much wheat at too high a cost, the Government should evaluate options for future agricultural growth. The exhaustion of options for new sources of irrigation water (productivity improvements depend on obtaining 'more crop per drop') and the need for production systems to become more resilient as climate change progresses, add urgency. Box 14 highlights possible directions for reforms in wheat support mechanisms, for economic efficiency, reducing burden on public purse, and ensuring protection of most food-insecure households. These measures support the transition to private sector-led trade with accompanying measures such as safety nets and (reduced) emergency stocks. Their implementation is expected to result in significant fiscal savings (lower burden on public purse) and social benefits (through lower price to consumers). Some of these measures are being implemented in the context of the Punjab SMART Program, notably in limiting

the volume of the security stock. Similar initiatives would be valuable to reform the subsidies of other crops, such as sugarcane.

Liberalize Agricultural Markets

Box 14. Possible Wheat Sector Reforms

- *Use international trade and limited national security stocks to promote price stability:*
  - Liberalize food imports by the private sector and announce a government policy of promoting private sector trade. With this reform, the international market will provide a price ceiling for Pakistan, equal to the import parity price, except in exceptional cases.
  - Promote exports in years of abundant domestic supplies and moderate international prices.
  - In exceptional years of high world prices, restrictions on exports and either subsidized open market sales or transfers of government wheat imports may be required to prevent excessive price increases in Pakistan's domestic markets.
- *Maintain a limited security stock of 1.5 to 2.0 million tons (at the end of April) to be used in two ways:*
  - To reduce domestic prices in years of low domestic production and high international prices (case 1c above).
  - To provide resources for emergency wheat distribution targeted to food-insecure households. Gradually reduce or eliminate domestic procurement of wheat.
- *Limit domestic procurement to a preannounced target quantity of 1–2 million tons per year (for purposes of stock rotation) to be procured at domestic market prices through open tenders or at a preannounced support price that is consistent with about 1–2 million tons of procurement.*
- *Eliminate the subsidy on sales of wheat to flour mills by selling wheat (for purposes of stock rotation) through auctions.*
- *Establish a wheat policy platform to facilitate information sharing and policy dialogue regarding market conditions and proposed policy changes.*
  - This will enhance transparency of government actions and promote more efficient markets.
  - The platform would include representatives of the Government, private-sector millers and traders, farmers' organizations, and consumers.
- *Strengthen analytical units within the Ministry of Agriculture or other institutions to enable timely and rigorous analysis of wheat markets and policy options.*
- *Strengthen conditional cash transfers and employment safety nets targeted to the poor.*
- *Use futures markets that in the medium term could contribute to increased wheat market efficiency.*
  - Use of international futures markets by government agencies could lessen some of the risks involved in reliance on international markets in years of large price increases. This would reduce any subsidy on sales of public sector imports in the event of a domestic production shortfall and high international prices.
  - Similarly, in the medium term, if the Pakistan commodity exchange develops, large farmers, private traders, millers, and the Government could hedge against price risk through futures market contracts.

Source: Dorosh et al., 2016.

Marketing of crops and livestock products in Pakistan is in urgent need of modernization. In Punjab, for example, marketing of agriculture products, apart from cotton, sugarcane, and wheat, is regulated by the 1978 Punjab Agricultural Produce Markets Ordinance (PAPMO). Under PAPMO, the Government has a monopoly on the establishment of wholesale markets (*mandis*). Only a limited number of licensed dealers (commission agents or *artis*) are allowed to operate in the market. Market fees are high and not commensurate with the level of services provided. The Punjab Agricultural Marketing Regulatory Authority (PAMRA) Act is a step in the right direction because it will significantly liberalize the agricultural marketing system. It allows any person, subject to registration, to set up a market dealing in primary agriculture products and improves regulations governing these markets. The act was passed by the Punjab Assembly on May 16, 2018, and published in the gazette on May 24, 2018. It is a milestone under the Punjab SMART

Program and a major step toward agricultural marketing modernization, which could inspire similar actions in other provinces.

For livestock products, occasional price caps have little effect on prices paid by consumers, but act as a negotiating factor for middlemen buying milk from producers and as a rent extraction mechanism for local officials. A similar situation prevails in the meat market. Price capping also acts as a disincentive to produce better quality products. Discontinuation of notification of meat and milk prices would stimulate production and marketing of larger quantities and better quality and safer livestock products, thus raising the incomes of livestock farmers, while enhancing supplies to urban areas.

Enable the Transition to Climate-Smart Agriculture

A third area for policy and institutional reforms, in the sense of a more productive and resilient agricultural sector, relates to facilitating the transition to climate-smart agriculture, by developing instruments for risk mitigation and supporting R&D for diversified and climate-resilient agricultural production. Beyond climate adaptation, the transition to climate-smart agriculture would also support climate mitigation in a sector responsible for approximately 41 percent of all GHG emissions in the country, mostly through livestock production (CIAT and World Bank, 2017).

Setting Up Instruments for Risk Mitigation

A risk management system would help safeguard farmers from the adverse impacts of weather hazards on crops and livestock. The system would aim to reduce livestock and crop loss in climate vulnerable areas, and build the resilience of farmers by providing them with coping mechanisms and strategies to deal with climate shocks. A risk management system would focus on coping with climate risks and include the following elements:

- **Climate Information Services (CIS).** Strengthened hydrological and meteorological information services can deliver reliable and timely climate information on floods, droughts, and other weather events. Focus is needed to ensure that farmers can access downscaled, locally relevant, and understandable/actionable weather information and that CIS and alerts are integrated within the agricultural advisory services. Dissemination needs to be done at the federal, provincial, and district levels. The climate information can also be used to develop climate indexes to trigger early warning and response or (parametric) insurance (see Box 15, for an insurance scheme being piloted in Punjab).

- **Safety net system for climate resilience.** Safety net systems help households better respond to various shocks, including climate-related risks, mitigate their consequences, and reduce vulnerability. The Benazir Income Support Program (BISP) was established and strengthened by the development of the National Social Protection System while responding to the global food, fuel, and financial crisis during 2008-09, and by implementing the Citizens Damage Compensation and Flood Emergency Cash Transfer Programs in the aftermath of the unprecedented floods of 2010. The BISP's initial objective was 'to cushion the adverse impacts of the food, fuel and financial crisis on the poor', but its broader objective is 'to meet the redistributive goals of the country by

providing a minimum income support package to the chronically poor and those who are more likely to be affected negatively by future economic shocks'. Building upon such experience, Pakistan has further strengthened the link of safety nets and disaster response according to the Federal Disaster Response Action Plan (FDRAP). The Adaptive Safety Net model defined in the plan covers both horizontal and vertical expansion, and related institutional mechanisms, which have been used in all disasters post 2011. In parallel, public works (for example, cash-for-work and/or food-for-work programs) could be triggered by CIS if it issues a warning of the chances of harvest failure. Such public works not only provide adaptation measures for households at risk, but also mitigation measures by facilitating efforts for agricultural soil and water conservation, which will also strengthen resilience in the long term.

- **Capacity building.** Local, provincial, and national authorities require strengthened capacity to use CIS, provide outreach to farmers and communities, and activate programs on time. Coordination across government departments, such as the National Disaster Management Authority (NDMA), the Pakistan Meteorological Department, the Ministry of National Food Security and Research, and provincial departments will need to be strengthened to enable the development of locally relevant CIS. This needs to be done to supplement, and in coordination with, similar ongoing and pipeline activities.

Box 15. Expanding Access to Crop and Livestock Insurance in Punjab

Access to crop and livestock insurance for farmers in Punjab is becoming increasingly important as weather patterns become more variable. The Crop Loan Insurance Scheme (CLIS) provides insurance cover to banks for default of farmers' loans and has been in existence since 2008. It is mandatory for all seasonal crop credit borrowers with less than 25 acres of cultivated land. An estimated 700,000 farmers in Punjab (13 percent of total) were insured in 2016-17 under the CLIS. The CLIS primarily protects banks, but does not protect farmers from loss of crop revenue (and not all types of production are covered). Moreover, the declaration by the local government of a disaster appears to be rather subjective; banks are required to pre-finance the premiums and reclaim the premium (subsidized 100 percent) from the Government; and there are delays of one and two years for banks being reimbursed by the Government. Since 2015-16, the federal government has supported a livestock credit-guarantee insurance, which covers individual animal mortality for cattle and buffalo. However, to date, the uptake of this program has been low.

In the context of the World Bank-financed project SMART in Punjab, GoPunjab will pilot the roll-out of a crop insurance scheme that would stabilize farmers' incomes and sustain their resilience in the face of natural events that reduce harvests. It includes the ongoing piloting of an insurance scheme for rice and cotton for semi-commercial farmers in four districts in Punjab (Sheikhupura, Lodhran, Sahiwal and Rahim Yar Khan). Eventually, when scaling up the program to other districts, the intention is to include the more than 2 million subsistence farmers in Punjab in the scheme and have the GoPunjab take out insurance on behalf of all of them as a safety net program.

Research and Development

A better performing AIS is essential to support the paradigm shift in Pakistan's agriculture sector and improve land and water productivity. Current shortcomings and limitations of the AIS in Pakistan point to low public funding, and strategic and organizational issues, as well as a lack of focus on non-major crop diversification and value-chain development. To facilitate the transition to more productive and sustainable, climate-resilient agricultural production systems, it will be necessary to: invest in better agricultural policy and economic analysis (for example, to better understand the scope for different value chains or assess options to reform subsidies);

better R&D (for example, to support development of cultivars more suited to changing climate conditions or diversification in horticulture and vegetables); and better extension services (for example, to raise awareness and improve the capacity of farmers around climate-smart technologies and practices, such as precision irrigation). Overall, public funding for AIS is comparatively low and, as a long-term goal, Pakistan could increase the spending on AIS to at least 1 percent of its agriculture GDP (some of which could be funded through a reshuffling of costly subsidies to the sector). To improve the relevance, efficiency, quality, and effectiveness of the AIS, the following six directions have been identified in the context of Punjab (Byerlee et al., 2018) and they could inspire similar undertaking in other provinces:

(i) Revamp and upgrade the Punjab Agriculture Research Board (PARB), including by creating a dedicated fund for agricultural innovation on a competitive grant basis and by strengthening planning, coordination, and evaluation.
(ii) Establish a state-of-the-art Punjab Horticulture Research Institute and create a Punjab Horticulture Board (PHB), to cover one of the fastest-growing subsectors in agriculture not appropriately serviced by the existing AIS.
(iii) Develop a capacity development strategy and establish a state-of-the-art Punjab Training Institute for Agriculture, to invest in human capital, both staff and value-chain stakeholders alike.
(iv) Undertake administrative reforms to improve research and extension, including strengthening the quality of science and rationalizing research programs, scaling up the use of modern communication technologies, and transforming the extension approach from general to specialized extension, as well as greater engagement of the private sector in research and extension.
(v) Undertake structural reforms to improve strategic alignment and rationalize public oversight of the AIS.
(vi) Improve links within the AIS to enhance knowledge creation and utilization in the service of agricultural stakeholders.

Table 3. Key Choices for Managing Land and Water Sustainably

Key choices for managing land and water sustainably: The agriculture-water nexus	Short term	Medium - long term
Key measure 1: Encourage efficient water use		
• Establish a process of basin-scale water resource planning and management, supporting cooperation between agencies (e.g., Water, Agriculture, Hydromet, etc.) and among Provinces – Federal government	X	
• Lead a formal review of the Water Apportionment Accord and work to capture appropriate interprovincial water sharing arrangements in federal legislation – Federal government	X	
• Establish a formal participatory water planning process that defines appropriate sectoral water allocations and the mechanisms for managing periods of temporary scarcity that recognize the relative economic, social, and environmental priorities for water – Provincial government	X	
• Map out and monitor groundwater (level and fluxes – abstraction and recharge) and quality (including pollutants from agriculture, municipal, and industrial waste), and communicate results to all stakeholders – Provincial government	X	

• Pass and enforce legislation for groundwater use (that is, tube well registration and licensing, monitoring, and volumetric pricing for water extraction) – Provincial government		X
• Strengthen the capacity of provincial agencies in overseeing irrigation flows (e.g., better modelling and forecasting, better understanding of conjunctive use, better monitoring, etc.) – Provincial government	X	X
• Test new models of irrigation management to irrigation service governance and delivery (for example, increased role of water users, partial devolution to water user associations of *abiana* setting and collection and use) – Provincial government	X	
• Improve *water tariff* collection - Provincial Irrigation/Water Departments.	X	
• Modernize canal systems to increase control on water distribution and improve measurement of water distribution – Provincial government	X	X
• Test innovative approaches (for example, remote sensing) for volumetric measurement – Provincial government	X	
• Develop and implement differentiated water tariff structure reflecting service quality and consumptive use – Provincial government		X
Key measure 2: Improve land productivity		
• Modernize wheat marketing, including phasing out of wheat procurement by the Government and help farmers diversify to high-value agriculture - Provincial Agriculture Departments.	X	
• Back modernization of wheat marketing, including reform of the wheat procurement system - National Ministry of Food Security and Research.	X	
• Liberalize crop and livestock markets - Provincial Agriculture Departments.	X	
Key measure 3: Enable the transition to climate-smart agriculture		
• Reform provincial agricultural research and extension systems - Provincial Agriculture Departments.	X	
• Reform the national agricultural research system (PARC and National Agricultural Research Center) - National Ministry of Food Security and Research.	X	
• Help farmers adjust to climate change through adoption of climate-smart agricultural technologies (e.g., water-saving technologies, drought/heat-resistant crops) and crop and livestock insurance - Provincial Agriculture Departments.	X	X

CHAPTER 3: BUILDING RESILIENCE TO NATURAL DISASTERS

3.1 THE HEAVY TOLL OF EXTREME WEATHER EVENTS, PARTICULARLY FLOODS

Climate change compounds environmental challenges. Changing climate already manifests itself in rising temperatures and more prevalent heatwaves, melting in the cryosphere, and an increased risk of GLOF in mountainous regions, as well as a rising sea level, accelerated costal erosion, and salination of surface and groundwater. Meanwhile, extreme weather events have grown in severity, with high human and economic costs. Climate change will intensify over the coming decades, making water resources less predictable with more erratic patterns and extremes on the rise, such as heatwaves, droughts, and floods. In addition, a rising sea level and saline intrusion will continue to threaten coastal infrastructure, agricultural lands, and aquifers in Karachi and the adjoining Indus deltaic region. Climate out-migration can be expected to occur from coastal areas because of sea level rise and storm surges.

Development challenges will be heightened with increased occurrences of climate change. In the absence of adaptation, climate change will have profound implications for growth, causing annual losses of about 1 to 2.7 percent of GDP equivalent, and for poverty reduction, pushing between 5.7 and 21.4 million additional people into poverty by 2050. The National Climate Change Policy 2012 and implementation framework view climate change as a compounding challenge that will aggravate current development challenges in Pakistan and highlight, in particular, water resources and agriculture as vulnerability hotspots.[31] The annual economic impact of flooding is estimated to be between 0.5 and 0.8 percent of GDP. Mostly because of monsoon rains from July through September, Pakistan experiences frequent and severe flooding in the Indus River Basin, where millions live in low-lying areas. Another major disaster was the drought of 1998 to 2002, which was considered the worst in Pakistan's recent history. Other extreme events, which are likely to become more prevalent with intensifying climate change, include heatwaves. Flood risk could increase significantly by 2030. GDP affected on average every year is expected to at least triple from current levels and population affected at least double. Drought risk is also expected to progressively increase as climate change intensifies.

A key dimension of vulnerability in Pakistan is exposure to hydrological and meteorological (hydromet) hazards, including storms, floods and droughts. Pakistan is ranked seventh on the Global Climate Risk Index and extreme weather events are expected to grow in severity, with high human and economic costs. Studies and Assessments by the Pakistan NDMA conclude that climate-related disasters resulted in an average economic loss of US$3.99 billion per year over the period 1994 to 2013 (MoCC, 2016). On average, 3 million people are affected by natural catastrophes every year, with floods being the dominant hazard (77 percent population affected), followed by drought (14 percent) and earthquake (4 percent). The annual economic impact of flooding is estimated to be between US$1.2 billion and US$1.8 billion, equivalent to between 0.5 and 0.8 percent of national GDP. Simulations show that a major flood event (occurring, on average, once every 100 years) could cause losses in excess of US$15.5

[31] http://www.lead.org.pk/cc/attachments/Resource_Center/NAP/pakistan.pdf.

billion, which equates to around 7 percent of national GDP, equivalent to almost 40 percent of the Federal Budget (World Bank and GFDRR, 2015). Two-thirds of populations affected historically are located in Punjab and 20 percent in Sindh (World Bank and GFDRR, 2015). While the financial cost of natural disasters in Pakistan – i.e., the damage inflicted on buildings, infrastructure, and agricultural production – is estimated at around 0.6 percent of GDP every year, their overall incidence on well-being is estimated to be much larger, at 0.9 percent of GDP equivalent, given the prevalence of poverty. In relative terms, poorer people suffer much more than wealthier people: they tend to be more exposed to disasters, so they suffer from higher relative losses to their assets and livelihoods, and bear a greater toll in terms of impacts on saving and investment behavior (Hallegatte et al., 2017).

Climate change is raising the risk of natural disasters with extreme events projected to increase in intensity and frequency. As global average temperatures continue to rise under the influence of anthropogenic GHG emissions, the incidence of extreme weather events has already witnessed a dramatic increase. Pakistan remains highly vulnerable to a diverse array of climatic shocks. Disaster risk management has therefore acquired ever more importance to strengthen resilience and sustainability of socioeconomic systems.

Mostly a result of monsoon rains in July through September, Pakistan experiences frequent and severe flooding in the Indus River Basin where millions live in low-lying areas. River flood risk is classified as high, meaning that potentially damaging and life-threatening river floods are expected to occur at least once in the next 10 years. The recurring flood events during 2010-14 alone resulted in monetary losses of over US$18 billion, with 38.12 million people affected, 3.45 million houses damaged, and 10.63 million acres of crops destroyed (MoCC, 2016). There are estimates that, following the devastating 2010 flood episode—the worst in 80 years—GDP was substantially lower than the projected GDP (4 to 5 percent) for several years (ESCAP, 2015).

In addition to climate-induced disasters, Pakistan is periodically affected by geohazard disasters. Major earthquakes (over 7.0 magnitude) have occurred frequently over the past decade, with the 2005 earthquake causing over 70,000 deaths in the northern parts of the country. With rapid urbanization and the expansion of the built environment, major cities in Pakistan are increasingly at risk to seismic shocks.

The mountainous northern regions of Pakistan are particularly vulnerable to climate risks owing to their unique geography. The warming climate has dramatically enhanced the risk of GLOF, as several glacial lakes have witnessed a surge in recent years. Changing patterns of precipitation and glacial melt are also having impacts on local livelihoods, which are closely tied to hydrological systems. The rising intensity and frequency of extreme events will increase the risk of landslides in this region. Landslides are a major hazard in mountainous areas where they can cause large-scale damage to life and property.

Other extreme events, which are likely to become more prevalent with intensifying climate change, include heatwaves, with the south of the country being so far most susceptible. In less than 30 years (1980 to 2007), the number of heatwave days[32] has grown by 31 days, or one full

[32] Defined as days in which the maximum temperature was more than the 90th percentile.

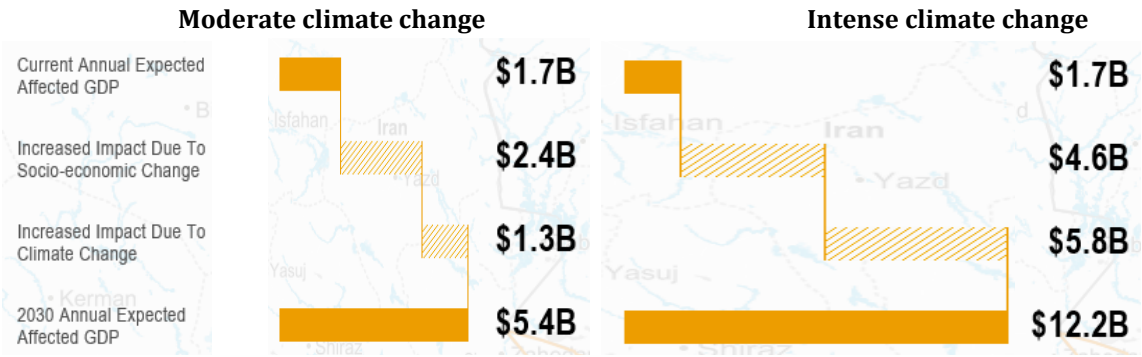
month, over Pakistan, with many regions experiencing between 30 to 60 additional heatwave days. Sindh, Punjab, and Balochistan are considered the most susceptible areas to heat-wave events in Pakistan (Zahid and Rasul, 2012). The unprecedented 2015 heatwave in Karachi took the lives of over 1,200 people and 200 more lost their lives in other parts of the Sindh province (MoCC, 2015).

3.2 CLIMATE CHANGE WILL AFFECT THE FREQUENCY AND INTENSITY OF NATURAL HAZARDS

Climate change is expected to increase the occurrence and severity of extreme weather events, including flooding, as well as the prevalence of heatwaves and droughts. As Pakistan's population and asset base increase, so will its economic exposure to disasters. The following paragraphs detail a few estimates of change in vulnerability for major hazards.

Flood risk could increase significantly by 2030. The GDP affected, on average, every year is expected to at least triple from current levels and the affected population is expected to at least double. In the worst case, economic losses could grow sevenfold and the affected population could grow fourfold (Figure 11). In all cases, climate change and socioeconomic development patterns contribute roughly equally to the increase in flood risk, emphasizing the large potential to reduce vulnerability and impacts through forward-looking planning.

Figure 11. The 2030 Flood Risk in Pakistan



Source: Aqueduct Global Flood Analyzer, World Resources Institute, http://www.wri.org//resources/maps/aqueduct-global-flood-analyzer.

Drought risk is also expected to progressively increase as climate change intensifies. The Standardized Precipitation Evapotranspiration Index (SPEI), calculated for a 12-month cumulative water balance, returns more and more negative values, indicating dryer conditions and severe impacts for ecosystems, crops, and water resources. By 2050, the annual probability of a severe drought (SPEI<-2) reaches 0.33, doubling from 2030 levels (World Bank, 2017b). The drought of 1998 to 2002, considered the worst in Pakistan's recent history saw the total flows of water in major rivers declining to roughly 34 percent below the monthly norm. Populations faced severe water shortages and major crop yields declined by 10 percent, causing internal migrations. Balochistan and Sindh were the hardest hit: in Balochistan alone, 2.1 million people were affected and some 40 percent of livestock perished (World Bank, 2018a). The drought episode also

resulted in major impacts on the economy, including lower growth on the back of reduced agricultural production and growing import of furnace oil to generate electricity given the country's temporary inability to rely on hydropower (United Nations Humanitarian Coordinator for Pakistan, 2001). The most seriously affected areas included Cholistan in Punjab, Thar in Sindh, and the Chagai-Kharan region in Balochistan. Balochistan is particularly vulnerable to droughts, as it has limited access to water from the Indus River Basin and lower endowment in groundwater resources compared with other provinces.

Heatwaves continue to intensify, with the warm spell duration index[33] increasing to 26 to 41 days by 2050, and by end of the century reaching 51 and 144 days in the RCP 4.5 and RCP 8.5 scenario, respectively (World Bank, 2017b). The rapidly urbanizing cities of Pakistan are particularly vulnerable to extreme heat events owing to socioeconomic characteristics and unplanned development. The 2015 heatwave episode in Karachi provided a stark reminder on the scale of this challenge, as more than 1,200 fatalities occurred in the city over the course of a few days. Unlike typical extreme events in the region such as floods, heatwaves impact large geographical areas with a small increase in average mortality rates. Hence management of this climatic hazard will require significant strengthening of the existing disaster response mechanisms and rethinking of urban development agenda.

3.3 CURRENT GOVERNMENT INITIATIVES ON DRM

Before the 2005 earthquake, Pakistan had a disaster response strategy predominantly centered on the 'Emergency Response Paradigm'. The post-2005 earthquake promulgation of the National Disaster Management Ordinance 2006 and the development of the National Disaster Risk Management Framework were reflective of the initial steps by the country to move toward a preemptive and proactive approach toward DRM. Since then, Pakistan has significantly improved regulations and institutional capacity for disaster management and has worked to change how the country addresses natural disasters—from an ex post disaster response perspective to an ex ante risk management approach, in line with the Hyogo Framework for Action (2005-15), and its successor, the Sendai Framework for Disaster Risk Reduction (2015-30).

The National Disaster Management Act (NDM Act) was passed in 2010, under which a National Disaster Management Commission (NDMC), headed by the Prime Minister, and disaster management authorities were established at the national and provincial/regional levels. The disaster management authorities were envisaged to have an integrated mandate encompassing the entire disaster management sector, including risk assessments, planning, preparedness, and early warnings, as well as response and recovery. Progress in setting up District Disaster Management Authorities (DDMAs) has been slower and these have only been implemented in a small number of districts.

[33] Measured by the consecutive occurrence of six or more days warmer than the 90th percentile of daily maximum temperatures.

The National Disaster Management Plan (NDMP) was adopted in 2012 as the key sector plan from the federal government and intends to direct and synchronize all mobilization of resources from public, private, development partner, and nongovernmental sources. The NDMP's overall goal is to achieve sustainable social, economic, and environmental development in Pakistan through reducing disaster risks and vulnerabilities, particularly those of the poor and marginalized groups; and to enhance the country's ability to manage all disasters using a comprehensive national approach. The NDMP envisages 10 disaster management interventions (Table 4) to establish an efficient and effective disaster management system in Pakistan.

Table 4. NDMP Interventions

1. Establish institutional and legal system for disaster management.	6. Strengthen DRR awareness programs at local level.
2. Prepare disaster management plans at various levels.	7. Infrastructure development for DRR.
3. Establish national hazard and vulnerability assessment.	8. Mainstreaming DRR into development.
4. Establish multi-hazard early warning systems (EWSs).	9. Establish a national emergency response system.
5. Training, education, and awareness for disaster management.	10. Capacity development for post-disaster recovery.

Note: DRR = Disaster Reduction and Recovery.

Following the passage of the 18th Constitutional Amendment in 2010, Provincial Disaster Management Authorities (PDMAs) have assumed an enlarged mandate and greater implementation responsibility to prepare for and respond to disasters. These agencies are increasingly at the forefront when responding to disaster situations. In the aftermath of such events, the PDMAs have led the Government's efforts in areas such as coordinating search and rescue, establishing temporary relief camps, supervising relief supplies and logistics, registering the affected population, and processing compensation payments (see Box 16 for an example of the response to the 2010 floods, using pre-paid cards, two rounds of targeting to improve timeliness, and a good grievance mechanism to address targeting errors).

Box 16. Pakistan: A Two-Phase Window To Balance Urgency With Targeting

Pakistan's main response to the devastating 2010 floods was the creation of the federal government's Citizen's Damage Compensation Program (CDCP), a rapid-response cash grant program—rather than using an existing social safety net mechanism. Drawing on positive prior experience from the 2009 civil crisis, it decided to deliver the cash transfers through commercial banks, working closely with provincial governments and the National Database Registration Authority (NADRA). Selected program beneficiaries were issued Visa direct debit cards, called *Watan* cards, for collecting grants from ATM machines or designated points of sale.

Phase I of the CDCP focused on immediate support. In Phase I (September 2010 to June 2011), the goal was to provide quick assistance to families who had lost their homes or faced a serious threat to their well-being. The program was funded by the Government, which provided almost US$400 million in cash grants to more than 1.62 million families (World Bank, 2013a). Eligible households were given a one-off cash grant in the amount of PKR 20,000 (about US$213), based on funds available to cope with the urgent needs of a very large flood-affected target population. The provincial and regional governments identified CDCP beneficiaries in two ways. A geographical targeting system was used in Punjab, Sindh, and Balochistan. Entire communities were identified as calamity affected through notification by each province of the flood-affected areas (determined by visually calculating that at least 50 percent of houses or crops were lost). A Rapid Housing Survey was used in KP province and the autonomous territories of Gilgit Baltistan and AJK, with families living in flood-affected housing units, rather than communities, being identified as flood affected. The findings from the Phase I evaluation showed that the funds helped households cover their needs at a crucial time (World Bank, 2013a), with the grants mostly being used for food, health needs, housing repair, and debt repayment (Hunt et al., 2011). However, the amount was insufficient for the flood-affected households to recapitalize their damaged or lost assets. The evaluation also suggested that for every 100 potentially eligible family heads, only 43 had received the *Watan* card. Inclusion and exclusion errors explain these results. Geographical targeting missed households that suffered damage, but lived in a weakly affected community; and the Rapid Household Surveys missed some damage and were conducted by local notables, not by experts able to detect all damage. Finally, the beneficiary selection and verification process proved to be lengthy and cumbersome, particularly for those who had lost the documentation necessary for verification either before, or during, the floods.

Phase II of the CDCP distributed larger amounts and was better targeted. In Phase II (June 2011 to June 2013), with total resources of around US$600 million, flood-affected households, including many of those from Phase I, were provided with cash payments that could be used to meet any recovery needs (like reconstructing houses, restoring livelihoods, or repaying accumulated debt). The size of the grant to eligible households was doubled to PKR 40,000 (around US$426), a more suitable amount to support recovery, provided in two installments of PKR 20,000 each. From the outset, measures were taken to address the targeting issues found in Phase I. These changes meant that not all Phase I beneficiaries were eligible for Phase II support and some people excluded from Phase I were included in Phase II. Housing damage was adopted as a proxy indicator for livelihood losses nationwide, rather than the geographic targeting method previously used in Balochistan, Punjab, and Sindh. This meant that the existing Rapid Housing Surveys could be used for targeting in KP and the autonomous regions, whereas new surveys needed to be conducted in the other three provinces. The eligibility criteria were further refined to filter out the wealthier and include particularly vulnerable households by adding two new eligibility criteria:

- Well-off households are excluded from receiving the Phase II transfer. Wealth is measured by a combination of proxies, such as those having bank accounts in international banks, frequent international travel activities, and executive jobs.
- All legitimate vulnerable beneficiaries (defined as female- and disabled-headed families in the NADRA's database) included in Phase I, but not captured as head of household through the housing damage survey, de facto, became Phase II beneficiaries.

The vulnerability characteristics of flood-affected families or households were profiled by analyzing a random sample from the NADRA's flood registration database and linking this with information on gender, disability, and educational levels in the civil registration database (World Bank, 2013a). In additional, the outstanding legitimate grievance claims from Phase I were settled and considerable resources used to strengthen the Government's communications, grievance redress, and policy and implementation capacities at different levels. The new targeting mechanism was cumbersome for good reason—with fairly large transfers, the focus had to be on reducing inclusion errors and then addressing the exclusion challenge through a rigorously applied grievance appeals system that came to play a critical role in determining

legitimate beneficiaries and drawing up beneficiary lists. Data suggest that Phase II was reasonably successful in targeting the most severely affected and the most vulnerable households (i.e., the poorest and least educated) in the four provinces (except Balochistan). However, beneficiaries experienced payment delays, with just 63 percent of households having received both tranches and 13 percent having received neither tranche—more than a year after the inauguration of Phase II and almost three years after the 2010 flooding. Grievance appeals are standard features in safety net systems and can be particularly important in emergency-type interventions, where often simple and straightforward selection procedures are applied within relatively short periods of time. They made for substantially improved targeting. Whereas initial beneficiary identification (the baseline) had resulted in the estimated exclusion of 61 percent of potentially eligible flood-affected households, with modified processes, and especially a fully operational grievance redress system, errors of exclusion were reduced to 32 percent. Where exclusion did occur, it was driven by difficulties in capturing people without identity cards (who would be automatically excluded), those without a permanent address, very isolated households, and those living in insecure areas. Enrolment difficulties were encountered, in particular, in Balochistan and Gilgit Balistan, where low administrative capacity in both areas, and stone-built, less flood-sensitive houses in the latter, resulted in few households being verified. Still, improved processes reduced exclusion errors in Balochistan to 30 percent, compared with a baseline of 73 percent.

A model of beneficiary registration and payment. The CDCP offers a model of how to establish an efficient decentralized beneficiary registration system for a very large number of clients over a widespread geographic area. By the end of Phase I, more than 1.6 million families were enrolled, and PKR 33 billion (US$374 million) was distributed (World Bank, 2013a). A further 874,000 *Watan* cards have been issued since then and nearly PKR 31.9 billion (US$337.6 million) disbursed during Phase II up to June 2012 (World Bank, 2013a). This is an impressive logistical and administrative achievement. Over the course of Phases I and II, the NADRA established 101 CDCP local offices, named *Watan* Card Facilitation Centers (WCFCs), covering all the flood-affected districts. The WCFCs serve as a 'one-stop shop', where the beneficiaries are enrolled, complaints or grievances are registered, and often payments are received through a point of sale machine. Biometric screening is used to verify the beneficiary identities to prevent fraudulent claims. Beneficiaries are then registered and issued a *Watan* card, which can be used at the point of sale desk or any ATM. In certain districts, the placement of a cash desk at the WCFC (i.e., on-site cash storage) was deemed a security risk and payments have been processed at a local bank branch, usually 1 km or 2 km away from the WCFC.

Source: Hallegatte et al., 2016.

The National Disaster Risk Reduction Policy (2013) was developed as an overarching policy document that seeks to identify key areas of interventions to increase the resilience of the country toward disasters. The policy identifies the following three key areas of interventions:

(a) **Risk knowledge.** Recognizing the need to identify and understand risk as the basis of not only DRM interventions, but also overall development, the Government established a National Working Group on Risk Assessments in 2012. Since then, the Government has rolled out multi-hazard and vulnerability risk assessments (MHVRAs) to many urban centers and priority districts to better understand the prevalent disaster and climate risks. These MHVRAs are contributing toward the creation of a national risk atlas, which requires input from technical agencies and line departments, which are the custodians of risk information. The effort has also resulted in the creation of a disaster risk database, which is a web-based Geographic Information System platform for sharing of risk information, including hazard, exposure, and vulnerability data. The World Bank also supported the Government in undertaking a fiscal disaster risk assessment (FDRA) at the national level to better understand its contingent liability from natural disasters. The assessment quantified the impact of natural disasters on the country's federal budget and estimated the economic cost of disasters by undertaking some probabilistic modeling for potential

losses from floods, to identify the expected average annual loss, and probable maximum loss. Financial risk assessments are now being carried out at the provincial level, to identify province specific economic impacts of disasters.

(b) **Prevention and mitigation.** The policy advocates creating resilient communities with DRR interventions at the local level, including the need to build links, information exchange and communication channels between community-based actors, local governments, and District Disasters Management Authorities (DDMAs)/Provincial Management Authorities (PDMAs). The GoP, through development partners, international and national nongovernmental organizations, and community support organizations is undertaking community-based disaster risk management (CBDRM) interventions across different parts of the country. The World Bank supported the establishment of a CBDRM program in Balochistan and is supporting the Governments of Punjab and Sindh in similar efforts. This area also supports resilient development by: (i) putting in place legislative and regulatory structures to promote DRR; and (ii) integrating DRR and climate considerations into development planning. In addition to setting up the DRM institutional and regulatory framework, consisting of NDMC, NDMA, PDMAs, and DDMAs through the NDM Act 2010, the Government has recently passed the Climate Change Act 2017, which establishes the Climate Change Authority and Climate Change Fund to advance the climate change agenda, which contributes toward prevention and mitigation of disaster and climate risks. The Government also approved the NDMP in 2012 and the Fourth National Flood Protection Plan IV (NFPP IV) in 2017 as key planning documents to mitigate disaster risks. Furthermore, this area of intervention supports the creation of risk mitigation infrastructure, particularly for the management of hydromet disasters. The NFPP IV is the premier document in this regard with costed interventions for resilient infrastructure. The World Bank is supporting many interventions under the NFPP IV at the provincial level in Sindh and Punjab, which also contribute toward climate adaptation.

(c) **Preparedness.** This area of intervention further focuses on: (i) improving institutional capacity; (ii) establishing an EWS; and (iii) advancing fiscal resilience. Many capacity-building initiatives have been undertaken at the federal and provincial levels to better prepare for ad hoc responses to disasters and climate variability. The World Bank continues to support the provincial governments in institutional strengthening, increasing outreach to districts and communities, and improving response capabilities of PDMAs and other line departments through its ongoing projects. At the national level, the NDMA seeks to establish a national disaster response force and strengthen the existing urban search and rescue (USAR) teams. Effective hydromet and climate services are critical factors in saving lives and livelihoods. The Government has also embarked upon a program to modernize its hydromet network and establish a countrywide EWS. The World Bank is supporting these efforts through a US$188 million investment in the hydromet sector, which would lead to improved observation data and forecasts, and site-specific information from the Pakistan Meteorological Department (PMD) on various time scales, including the introduction of impact-based forecasting in the country.

Although the GoP has taken the necessary legal, institutional, and policy measures for DRM, several entities in addition to NDMA are working on DRM with overlapping mandates at the federal level. These include the Earthquake Reconstruction and Rehabilitation Authority, the Emergency Relief Cell, and the Federal Flood Commission, among others. This multiplicity of institutions at the provincial level includes the PDMAs, the Provincial Irrigation Departments, and the Civil Defense and Rescue Services. Similarly, in addition to the National Disaster Management Ordinance of 2006, multiple legal parameters cover disasters and emergency situations that overlap between government agencies and tiers.

The heavily decentralized approach to DRM in the provinces is a key contributor to these challenges. DRM procedures lack standardization across provinces despite specifications in the NDM Act of 2010. In general, the DRM system defined in the NDM Act of 2010 and national disaster response plans are not fully followed at the provincial level and DRM approaches vary across the provinces. In Punjab, for example, disasters are typically managed following instructions given in war books such as the financial war book and other provinces still follow instructions in the Natural Calamities Act of 1958. Other legislation that affects DRM includes the Earthquake Reconstruction and Rehabilitation Authority (ERRA) Act of 2011 and Civil Defense Act of 1952. Currently, no institutional mechanisms exist to calculate the financial impacts of disasters within the federal or provincial treasuries. After a disaster, with the support of the World Bank and ADB, the GoP undertakes a damage and needs assessment, which estimates the direct losses, as well as the reconstruction costs by sector and province across both the public and private sectors. The post-disaster financial responsibilities of provincial governments are not well-defined. In addition to these expenditures, other relief mechanisms may be provided. In Punjab, for instance, short-term waivers on water and land taxes are common following a disaster. In certain cases, waivers of interest on agriculture loans and delays in the repayment of these loans are allowed.

Securing access to financial resources before a disaster strikes is important. Natural disasters generate significant fiscal risk and create significant budget volatility; therefore, putting in place measures for financial protection is a key part of preparedness. The NDM Act 2010 allows for the establishment of disaster management reserve funds at the national and provincial levels, which is one form of financial protection. While the Government has established a National Disaster Risk Management Fund (NDRMF) to finance risk reduction activities, the provincial governments are also in the process of establishing provincial-level DRM funds. Furthermore, Punjab, Sindh, and KP provinces are developing disaster risk financing (DRF) strategies, which would bring together different financial tools and instruments to increase fiscal resilience. The Government is also in the process of developing agri-insurance for farmers, to protect against disasters and climate risks.

3.4 TOWARD ENHANCING RESILIENCE TO DISASTERS

Identify and Mainstream Risk in Development Planning

Pakistan can significantly reduce disaster losses over time by acting to stem the ever-increasing process of risk creation resulting from uncontrolled development processes, and investing in risk reduction to address the existing risks. Risk identification/analysis and the integration of risk information/knowledge in land use and territorial development, urban planning, and design of public infrastructure, as well as the adoption and monitoring of better building standards, are effective ways to reduce risk over time. Risk assessment/analysis can also be used to identify existing sources of risks, and prioritize and design interventions to address these risks. The Government needs to undertake a multi-hazard risk assessment for the country, to be updated periodically, to provide a scientifically informed assessment of the level of hazard risk and vulnerability across the country. Risk identification and developing risk profiles of geographic regions and demographic clusters will guide mitigation investments and development planning.

Once disaster risks have been identified, they must be communicated in a manner that motivates the users of that information to increase resilience to disasters. Governments, civil society, and the private sector can raise awareness of risks and risk mitigation principles at the national, regional, and community levels. Awareness leads to public demand for risk-resilient policies and this can in turn lead to sustainable development in the future, in line with the Sustainable Development Goals. This is the crucial step in cultivating behavioral and institutional changes that are necessary to shift from a culture of emergency response to one of preparedness in Pakistan.

Increase Fiscal Resilience through Disaster Risk Financing and Transfer

The recurring disaster situation in Pakistan necessitates the development of DRF mechanisms to help the Government cope with the financial impact of disasters. The Government needs the ability to manage the internal (disaster reserve funds, budget reallocation, and internal credit) and external (external assistance, credit, and insurance or reinsurance payments) funds necessary to finance response, recovery, and reconstruction needs, while protecting its fiscal balance and preventing harm caused by reallocations from other priorities.

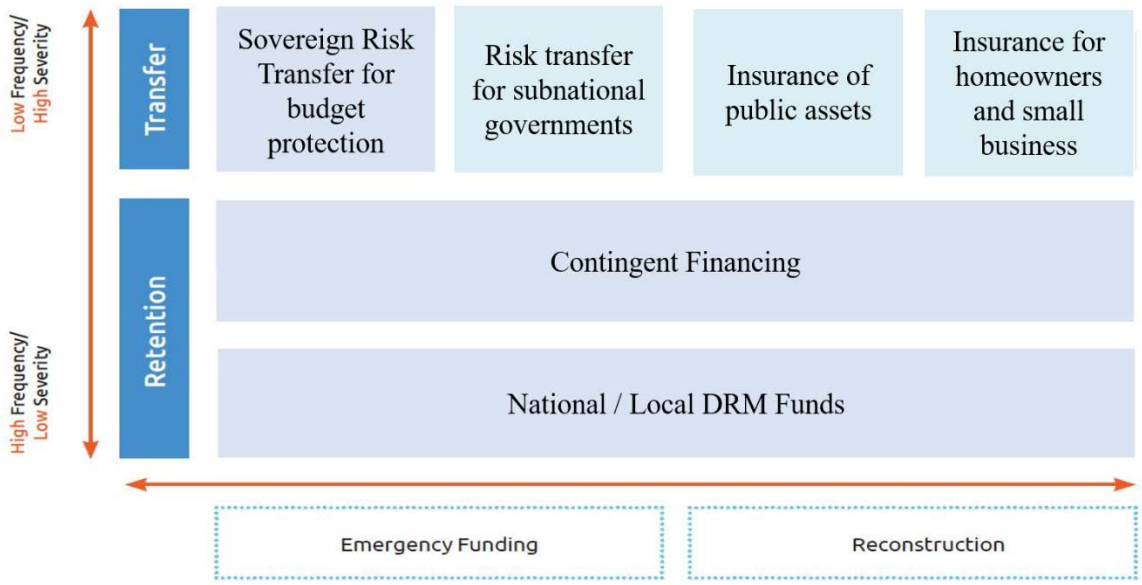
The NDM Act (2010) requires annual budgetary allocations for DRM as one measure to deal with financial shocks from disasters. The act also intends for these funds to be used for disaster risk reduction activities to reduce the overall risk from natural disasters. However, to date, this budgetary allocation has not been practiced in a systematic or regular manner. Allocations are made in an ad hoc manner to the DRM authorities by finance departments, either in anticipation of a disaster, particularly before the annual monsoon season, or after the disaster has struck. As a result, any funds allocated in this manner are essentially earmarked for response activities and are not channeled toward risk mitigation.

Beyond systematic and regular budgetary allocations to cope with the aftermath of disasters, it is necessary for Pakistan to enhance financial protection against climate and disaster risks through a comprehensive framework of risk financing instruments to improve early and comprehensive responses to disaster events.

In the aftermath of the 2010 floods, which caused over US$10 billion worth of damage and losses across Pakistan, the Government felt the need to not only identify physical risks from a multi-hazard perspective, but also assess financial risks from natural disasters. This was because the country had suffered more than US$15 billion in damage and losses within five years from two major natural disasters, providing a huge setback to the economy. Both the NDMP and National Disaster Risk Reduction Policy prioritize the need for multi-hazard risk assessment and the development of a risk financing mechanism. In this context, and through the World Bank's dialogue on DRM in the country, the Government requested the World Bank's support for identifying physical and fiscal risks from disasters. As part of identifying fiscal risks, the World Bank, in collaboration with the Ministry of Finance, the Securities Exchange Commission of Pakistan (SECP), and NDMA prepared an FDRA report for Pakistan that quantified the impacts of natural disasters on the country's budget. As part of preparing a DRF program for the country, the FDRA was the first milestone and a prerequisite for developing a DRF strategy.

There is now a need to take the DRF agenda forward by developing DRF strategies, both at the federal and provincial levels. The DRF strategy would establish clear priorities enabling the Government to make an informed choice on accessing various sources of funding to respond to disasters, from a combination of ex ante and ex post financial instruments. The strategy would bring together different financial instruments to protect the Government against disasters of different frequency and severity. Such financial instruments could include reserve funds, risk transfer mechanisms, contingent credit, and cash transfer mechanisms under the existing social protection programs in Pakistan. It would address the need for resource mobilization, as well as budget execution on time and in a transparent fashion. The Governments of Punjab, Sindh, and KP have initiated the preparation of DRF strategies at the provincial level. The following figure outlines the portfolio of solutions and instruments that can be accessed for disaster risk financing:

Figure 12. Layered Approach for Financial Protection



Strengthen Disaster Risk Management Governance

The multiplicity of institutions and regulatory frameworks in DRM often create a bottleneck in ensuring effective DRM service delivery. One immediate action required is to streamline the roles and responsibilities of the institutions in the DRM sector by reviewing and revising the existing legislation, regulatory frameworks, and institutional mandates at the federal, provincial, and city/district levels. This would allow for improved planning and preparation, as well as an efficient and coordinated response after a disaster event. The Government has initiated the first step in this regard by undertaking an institutional review of the DRM governance structures. The recommendations of the review would be implemented through the support of the World Bank-funded Pakistan Hydromet and DRM Services Project.

It is essential that DRM governance reforms are backed by institutional strengthening measures aimed at supporting local and national disaster management agencies. This would involve training disaster management officials in disaster risk reduction, EWSs, response and recovery, and developing competencies from the local to national levels to identify and mitigate risks.

Strengthen Infrastructure for Resilience

Due to rapid urbanization and unplanned construction, coupled with inadequate management of infrastructure, the vulnerability of the population has grown over the past decades. The underlying risk needs to be mitigated by strengthening infrastructure and promoting safe construction practices. The NFPP IV outlines the infrastructure needs for the next decade to mitigate flooding risk in vulnerable areas. In addition to flood-prone areas, there is a need to address structural vulnerability in urban centers. Based on the risk information generated by risk assessments, the Government needs to identify a priority list of critical infrastructure in urban areas that requires retrofitting to reduce structural risk.

Infrastructure investments need to be supported through reforms in construction practices, particularly in urban centers. The current regulatory environment governing the construction sector in Pakistan is opaque and the enforcement mechanisms for urban development control do not address structural safety. This creates an environment that lacks practical enforcement capability and accountability. In this context, physical and social vulnerabilities keep increasing risks, such as earthquakes, floods, fires, or building collapses, and present a formidable threat to life and economic well-being. Thus, there is a need to not only periodically update the building code, but also to ensure its enforcement to mitigate structural risk.

Use Social Protection Systems for Resilience

The country's DRM system can build on and expand the existing social protection systems. Pakistan has been building robust social protection systems through the BISP, which could be further strengthened to: provide mechanisms for climate-smart targeting; outreach to vulnerable and at-risk households; enrolment for programs designed for disaster relief or responses (for example, public works, assets building, or livelihoods programs); payment transactions to support disaster recovery of households and communities; and monitoring and tracking of outcomes. For the social protection systems to effectively respond to shocks and contribute to DRM, social protection information, such as the National Socio Economic Registry (NSER) containing information on household composition, characteristics, and locations, can be tied to understanding of risks and vulnerabilities, along with pre-positioned risk financing. Early warning and related risk information (for example, hazard mapping, market monitoring, climate information, conflict mapping, and geospatial data) can provide vital information about the nature, location, and depth of a shock, as well as the appropriateness and type of responses. Institutionally, the Government depicts its adaptive safety net response to disasters under the FDRAP. This flexible and scalable model caters to both horizontal and vertical expansion through a time-tested institutional mechanism. The vertical expansion includes top-ups for the extreme poor who are already beneficiaries of the BISP and the program has already provided support to more than 350,000 families in the earthquake-affected populations of Balochistan, Malakand, and Federal Administered Tribal Areas (FATA) regions, and the drought-affected population of Tharparkar. Horizontal expansion kicks in whenever there is a need to provide support to an affected population outside the ambit of the regular safety net, based on geographical, categorical, or conditional targeting criteria. For such a kind of expansion, the Government's disaster response focal agency with the help of the NADRA is called upon to respond in the aftermath of natural or artificial disasters through the setting-up of one-stop shops.

Table 5. Key Choices for Building Resilience to Disasters

Key choices for building resilience to disasters	Short term	Medium - long term
• **Key measure 1: Strengthen the capacity of DRM authorities, particularly by establishing and operationalizing district- and city-level disaster management authorities.** The district and local administration are usually the first responders in a disaster situation and have the closest links with communities. Furthermore, there is a need to streamline roles, responsibilities and mandates of various institutions involved in DRM, as part of strengthening the overall institutional framework.	X	
• **Key measure 2: Complete multi-hazard risk assessments across the country to identify the risk environment**, as the first step toward moving to risk-informed planning and decision-making.	X	
• **Key measure 3: Put in place a DRF program that would entail a mix of financial instruments to protect the country from fiscal shocks because of natural disasters.** The first step would be to develop national and provincial disaster risk financing strategies to set out DRF priorities for the next five years.	X	
• **Key measure 4: Increase the amount of climate knowledge available in the county through specific and targeted analytical work and awareness initiatives**. Pakistan's international commitments on climate change, that is, NDCs, should be unpacked in the form of an implementation road map and investment plans for key sectors.	X	
• **Key measure 5: Direct investments toward risk mitigation infrastructure to reduce the potential risk of disasters and climate impacts**, such as hydromet and seismic disasters. Infrastructure should also contribute toward meeting Pakistan's NDC commitments for adaption and mitigation.		X
• **Key measure 6: Climate and disaster risk should become an integral part of short- and long-term planning in the country**. Climate-sensitive planning should be promoted across all public-sector institutions, for sustainability of development initiatives, and to ensure that climate change is included as a key issue in the national narrative.		X

REFERENCES

Ahmad, Shahid. 2009. "Water Availability and Future Water Requirements." *Project Management and Policy Implementation Unit of the Ministry of Water and Power (MOWP) Water Conservation, Present Situation and Future Strategies*. Proc. MOWP, Planning Commission and Asian Development Bank National Seminar. Project Management and Policy Implementation Unit MOWP, 43–62, Islamabad, Pakistan, May 21.

Ahmad, Shahid. 2017. "Water Sector of Pakistan: A Situational Analysis." In Water Security: Pakistan's Most Critical Development Challenge, *Development Advocate Pakistan*, edited by Maheen Hassan. Volume 3, Issue 4.

Aslam, M. 2016. "Agricultural Productivity Current Scenario, Constraints, and Future Prospects in Pakistan." *Sarhad Journal of Agriculture* 32(4): 289–303.

BIPP (The Shahid Javed Burki Institute of Public Policy at NetSol). 2016. *The State of the Economy Agriculture and Water*. Available at http://www.sjbipp.org/publications/AR/reports/AR-09-16.pdf

Byerlee, Derek,Mubarik Ali, Jock R. Anderson R, and Hans G.P. Jansen. 2018. *Diagnostic Assessment of the Punjab Agricultural and Livestock Innovation System: Achievements, Constraints, and Ways Forward*. World Bank.

Chang, T., Joshua Graff Zivin, Tal Gross, and Mathew Neidell. 2016. "The Effect of Pollution on Worker Productivity: Evidence from Call-Center Workers in China." NBER Working Paper 22328. Available at: http://www.nber.org/papers/w22328.pdf.

CIAT (International Center for Tropical Agriculture) and World Bank. 2017. *Climate-Smart Agriculture in Pakistan.* CSA Country Profiles for Asia Series.

Davies, Stephen, Arthur Gueneau, Dawit Kelemework Mekonnen, Claudia Ringler, and Sherman Robinson. 2016. "Irrigation and Water Management in the Indus Basin: Infrastructure and Management Strategies to Improve Agricultural Productivity." Chapter 2. In *Agriculture and the Rural Economy in Pakistan: Issues, Outlooks, and Policy Priorities*, edited by David J Spielman, Sohail Jehangir Malik, Paul A. Dorosh, and Nuzhat Ahmad, 41–80. Philadelphia, PA: University of Pennsylvania Press on behalf of the International Food Policy Research Institute (IFPRI).

Dehlavi, Ali, Ben Groom, Ashley Grost, and Farruk Zaman. 2015. *A Micro-Econometric Study of the Determinants, Impact and Cost Effectiveness of Adaptation Strategies*. WWF-Pakistan: Karachi.

Dickin, Sarah, Corrine Schuster-Wallace, Manzoor Qadir, and Katherine Pizzacalla. 2016. "A Review of Health Risks and Pathways for Exposure to Wastewater Use in Agriculture" *Environ Health Perspect*. 124(7): 900–909.

Dorosh, Paul A., Elena Briones Alonso, Shuaib Malik, and Abdul Salam. 2016. "Agricultural Prices and Trade Policies". Chapter 7. In *Agriculture and the Rural Economy in Pakistan: Issues, Outlooks, and Policy Priorities.* Edited by David J. Spielman, Sohail Jehangir Malik, Paul A. Dorosh, and Nuzhat Ahmad, 41–80. Philadelphia, PA: University of Pennsylvania Press on behalf of the International Food Policy Research Institute (IFPRI).

Golub, Elena Strukova. 2018. *Cost of Environmental Degradation (CoED) in Pakistan: Benchmarking, Trends, and Economic Analysis* (draft).

ESCAP (United Nations Economic and Social Commission for Asia and the Pacific). 2015. "Overview of Natural Disasters and their Impacts in Asia and the Pacific: 1970–2014." ESCAP Technical Paper.

Gallup Pakistan, Daily Gilani Poll. 2016. "Environment Protection versus Economic Progress: Divided Public Opinion." Available at: http://gallup.com.pk/environment-protection-versus-economic-progress-divided-public-opinion/

Gallup Pakistan. 2017. "79% Pakistanis Cite Water Pollution to Be A Critical Problem (Very or Somewhat) In Their Locality, Followed By 78% Who Say Excessive Land Development". Available at: http://gallup.com.pk/79-pakistanis-cite-water-pollution-to-be-a-critical-problem-very-or-somewhat-in-their-locality-followed-by-78-who-say-excessive-land-development/.

Gallup Pakistan. 2015. "Only 31% Pakistanis Believe That It Is Necessary to Take Major Steps to Address Climate Change Very Soon". Available at: http://gallup.com.pk/only-31-pakistanis-believe-that-it-is-necessary-to-take-major-steps-to-address-climate-change-very-soon/

GFDRR (Global Facility for Disaster Reduction and Recovery). 2015. *Fiscal Disaster Risk Assessment Options for Consideration: Pakistan*. https://openknowledge.worldbank.org/handle/10986/21920.

Gill, M.A., and N.A. Awan. 2009. "Water Conservation through Resource Conservation Technologies." In: *Project Management and Policy Implementation Unit (PMPIU) of the Ministry of Water and Power*. *Water Conservation, Present Situation and Future Strategies*. Proc. Ministry of Water and Power, Planning Commission and Asian Development Bank National Seminar. Project Management and Policy Implementation Unit (PMPIU) 76–88, Ministry of Water and Power, Islamabad, Pakistan, May 21.

Gill, M.A., C.M. Ashraf, and M. Ahmad. 2002. "Pakistan's Experience in Resource Conservation Technologies for Combating Drought". In: *Drought and Water Management Strategies*. Edited by M. A. Kahlown, N. Yasmin, and M. Ashraf. Proc (Pub. # 122–2002 of PCRWR). Pakistan Council of Research in Water Resources (PCRWR). SAARC Workshop. 61–75. Pakistan Council of Research in Water Resources, Lahore, Pakistan. September 16–18.

Government of Pakistan: Ministry of Climate Change. 2012. *National Climate Change Policy*.

Government of Pakistan: Climate Change Division.2013. Framework for Implementation of Climate Change Policy (2014–2030).

Government of Pakistan. 2014. *Vision 2025: One Nation – One Vision*. Islamabad: Ministry of Planning, Development, and Reform.

Government of Pakistan. 2016. Agriculture Statistics of Pakistan (2014–2015).

Government of Pakistan. 2018. Ministry of Water Resources. *National Water Policy.*

Government of Pakistan: Ministry of Finance. 2018. Pakistan Economic Survey 2017–2018.

Hallegatte, Stephane, Adrien Vogt-Schilb, Mook Bangalore, and Julie Rozenberg. 2017. *Unbreakable: Building the Resilience of the Poor in the Face of Natural Disasters.* Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/25335

Hallegatte, Stephane, Mook Bangalore, Laura Bonzanigo, Marianne Fay, Tamaro Kane, Ulf Narloch, Julie Rozenberg, David Treguer, and Adrien Vogt-Schilb. 2016. *Shock Waves: Managing the Impacts of Climate Change on Poverty*. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/22787 License: CC BY 3.0 IGO.

Hunt, S., S. O'Leary, T. N. Jones, and Z. Ali. 2011. *Evaluating Implementation of Pakistan's Citizens Damage Compensation Program (Phase 1)* Final Report. Oxford, U.K.: Oxford Policy Management.

Hutton, Guy and Varughese, Mili. 2016. "The Costs of Meeting the 2030 Sustainable Development Goal Targets on Drinking Water, Sanitation, and Hygiene." World Bank, Washington, DC. https://openknowledge.worldbank.org/handle/10986/23681.

Ikram, F., M. Afzaal, S. A. A. Bukhari, and B. Ahmed. 2016. "Past and Future Trends in Frequency of Heavy Rainfall Events over Pakistan", *Pakistan Journal of Meteorology*, 12(24).

IMF (International Monetary Fund). 2015. *Is the Glass Half Empty or Half Full? Issues in Managing Water Challenges.*

IUCN (International Union for Conservation of Nature) Pakistan. 2010. "Pakistan Water Apportionment Accord for Resolving Inter-provincial Water Conflicts – Policy Issues and Options".

IUCN (International Union for Conservation of Nature) Pakistan. 2009. *Policy Gap Analysis: Government of Pakistan's Agriculture and Water Policies with Respect to Climate Change*. Islamabad: IUCN Pakistan. Retrieved from: https://cmsdata.iucn.org/downloads/policy_gap_analysis_report.pdf

Jacoby, Hanan G., and Ghazala Mansuri. 2018. "Governing the Commons? Water and Power in Pakistan's Indus Basin." *Policy Research Working Paper 8351*, World Bank, Washington, DC.

Jacoby, Hanan G., Ghazala Mansuri, and Fatima Freeha. 2018. "Decentralization and Redistribution: Irrigation Reform in Pakistan's Indus Basin." Policy Research Working Paper 8352, World Bank, Washington, DC.

Kahlown, Muhammad A., and M. Azam. 2002. "Individual and Combined Effect of Waterlogging and Salinity on Crop Yields in the Indus Basin." *Journal of Irrigation and Drainage Engineering* 51 (4): 329–338.

Kahlown, Muhammad A., M. Ashraf, M. Hussain, H.A. Salam, and A.Z. Bhatti. 2006*. Impact Assessment of Sewerage and Industrial Effluents on Water Resources, Soil, Crops, and Human Health in Faisalabad*. Research Report, Pakistan Council of Research in Water Resources, Islamabad.

Kirby, Mac, Mobin-ud-Din Ahmada, Mohammed Mainuddina, Tasneem Khaliqb, and M.J.M. Cheemaca. 2017. "Agricultural Production, Water Use, and Food Availability in Pakistan: Historical Trends, and Projections to 2050", *Agricultural Water Management* 179 (2017): 34–46.

Korea International Cooperation Agency. 2017. "Assessment of Country-wide Wastewater Management and Development of Strategic Action Plan for Sustainable Ecosystem" Project Concept Paper.

Landrigan, Philip J. et al. 2018. "The Lancet Commission on pollution and health." *The Lancet*, 391 (10119):462–512. Available at: http://dx.doi.org/10.1016/S0140-6736(17)32345-0

Lutz, A.F., W.W. Immerzeel, A.B. Shrestha, and M. F. P. Bierkens. 2014. "Consistent Increase in High Asia's Runoff due to Increasing Glacier Melt and Precipitation", *Nature Climate Change* (4): 587–592. doi:1.1038/nclimate2237.

Malik, Sohail Jehangir; Shujat Ali, Khalid Riaz, Edward Whitney, Mehrab Malek, and Ahmad Waqas. 2016. "Agriculture, Land, and Productivity in Pakistan". Chapter 2. In *Agriculture and the Rural Economy in Pakistan: Issues, Outlooks, and Policy Priorities*. Edited by David J. Spielman, Sohail Jehangir Malik, Paul A. Dorosh, and Nuzhat Ahmad, 41–80. Philadelphia, PA: University of Pennsylvania Press on behalf of the International Food Policy Research Institute (IFPRI).

Mani, Muthukumara, Sushenjit Bandyopadhyay, Shun Chonabayashi, Anil Markandya, and Thomas Mosier. 2018. *South Asia's Hotspots: The Impact of Temperature and Precipitation Changes on Living Standards*. Washington DC: World Bank.

MoCC (Ministry of Climate Change). 2015. Technical Report on Karachi Heat Wave.

MoCC. 2016. Pakistan's Intended Nationally Determined Contribution.

Nowak, D. Satoshi Hirabayashi, Allison Bodine, and Eric Greenfield. 2014. *"Tree and forest effects on air quality and human health in the United States"*, Environmental Pollution 193 (2014) 119e129

Radic, Valentina, Andrew Bliss, A.Cody Beedlow, Regine Hock, Evan Miles and J.Graham Cogley. 2014. "Regional and Global Projections of Twenty-first Century Glacier Mass Changes in Response to Climate Scenarios from Global Climate Models", *Climate Dynamics* 42(1–2): 37–58.

Rana, Muhammad Ahsan, David J Spielman, and Fatima Zaidi. 2016. "The Architecture of the Pakistani Seed System: A Case of Market-regulation Dissonance". Chapter 2. In *Agriculture and the Rural Economy in Pakistan: Issues, Outlooks, and Policy Priorities*. Edited by David J. Spielman, Sohail Jehangir Malik, Paul A. Dorosh, and Nuzhat Ahmad 41–80. Philadelphia, PA: University of Pennsylvania Press on behalf of the International Food Policy Research Institute (IFPRI).

Randhawa, Hafeez Akhtar. 2002. "Water Development for Irrigated Agriculture in Pakistan: Past Trends, Returns and Future Requirements". In *Investment in Land and Water: Proceedings of the Regional Consultation, BANGKOK (Thailand), October 3–5, 2002*. Food and Agriculture Organization of the United Nations. Available at http://www.fao.org/docrep/005/ac623e/ac623e0i.htm.

Rasul, Ghulam, Muhammad Afzal, Maida Zahid, and Syed Ahsan Ali Bukhari. 2012. *Climate Change in Pakistan: Focused on Sindh Province.* Technical Report No. PMD-25/2012, Pakistan Meteorological Department.

Rasul, Ghulam, Qamar-uz-Zaman Chaudhry, A. Mahmood, and W. Hyder. 2011. "Effect of Temperature Rise on Crop Growth and Productivity." *Pakistan Journal of Meteorology* 8: 53–62.

Sánchez-Triana, Ernesto, Santiago Enriquez, Bjorn Larsen, Peter Webster, and Javaid Afzal, with contributions from Elena Strukova Golub, Hammad Raza, Mosuf Ali, and P. S. Rajani. 2015. "Sustainability and Poverty Alleviation: Confronting Environmental Threats in Sindh, Pakistan." *Directions in Development.* Washington, DC: World Bank.

Sánchez-Triana, Ernesto, Santiago Enriquez, Javaid Afzal, Akiko Nakagawa, and Asif Shuja Khan. 2014. *Cleaning Pakistan's Air: Policy Options to Address the Cost of Outdoor Air Pollution*. Washington, DC: World Bank. Available at: http://dx.doi.org/10.1596/978-1-4648-0235-5

SDPI (Sustainable Development Policy Institute) and PRISE (Pathways to Resilience in Semi-Arid Economies). 2015. *Pakistan: Country Situation Assessment*.

SDPI. 2018. "Pakistan@100- Shaping The Future Environmental Sustainability In Pakistan" DRAFT.

Spielman, David J., Sohail Jehangir Malik, Paul A. Dorosh, and Nuzhat Ahmad.2016. "Food, Agriculture, and Rural Development in Pakistan". Chapter 1. In *Agriculture and the rural Economy in Pakistan: Issues, Outlooks, and Policy Priorities*. Edited by David J. Spielman, Sohail Jehangir Malik, Paul A. Dorosh, and Nuzhat Ahmad.1–40. Philadelphia, PA: University of Pennsylvania Press on behalf of the International Food Policy Research Institute (IFPRI).

UNDP. 2017a. *Pakistan - Climate Public Expenditure and Institutional Review*.

UNDP. 2017b. *The Vulnerability of Pakistan's Water Sector to the Impacts of Climate Change: Identification of Gaps and Recommendations for Action.*

UNEP (United Nations Environment Programme), World Meteorological Organization. 2011. "Integrated Assessment of Black Carbon and Tropospheric Ozone". UNEP/WMO, Nairobi, Kenya.

UNICEF (United Nations Children's Fund)/WHO (World Health Organization) Joint Monitoring Programme. 2017. Available at: https://washdata.org/.

United Nations-Water, World Health Organization. 2017. *Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS) 2017 Report: Financing Universal Water, Sanitation and Hygiene under the Sustainable Development Goals*. Available at: http://www.who.int/water_sanitation_health/publications/glaas-report-2017/en/

United Nations-Water, World Health Organization. 2017. *Climate Change Risk Profile: Pakistan*.

Van Donkelaar, Aaron, Randall V. Martin, Michael Brauer, N. Christina Hsu, Ralph. A. Kahn, Robert C Levy, Alexei Lyapustin, Andrew M. Sayer, and David M Winker. 2017.Global Estimates of Fine Particulate Matter using a Combined Geophysical-Statistical Method with Information from Satellites, Models, and Monitors, Environ. Sci. Technol, doi: 10.1021/acs.est.5b05833, 2016

WHO Global Urban Ambient Air Pollution Database. 2016. Available at: http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/

World Bank. 2006. *Pakistan - Strategic Country Environmental Assessment: Main Report*. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/132221468087836074/Main-report

World Bank. 2013a. *Pakistan's Citizens Damage Compensation Program (CDCP): Case Study.*

World Bank. 2013b. "Pakistan Water Supply and Sanitation Sector, Volume I Urban Water Supply and Sanitation," April 2013.

World Bank. 2014. "Indonesia - Second Phase of the Local Government and Decentralization Project: Additional Financing." Washington, DC: World Bank Group. Available at: http://documents.worldbank.org/curated/en/889281468254067416/Indonesia-Second-Phase-of-the-Local-Government-and-Decentralization-Project-additional-financing

World Bank Group and GFDRR (Global Facility for Disaster Reduction and Recovery) (2015). *Fiscal Disaster Risk Assessment Options for Consideration: Pakistan.* https://openknowledge.worldbank.org/handle/10986/21920

World Bank. 2016a. "High and Dry: Climate Change, Water and the Economy. Available at: Available at: http://www.worldbank.org/en/topic/water/publication/high-and-dry-climate-change-water-and-the-economy

World Bank. 2016b. *INDC Background Note on Adaptation.*

World Bank; Institute for Health Metrics and Evaluation. 2016. *The Cost of Air Pollution: Strengthening the Economic Case for Action*. Washington, DC: World Bank.

World Bank. 2017a. *Reducing Inequalities in Water Supply, Sanitation, and Hygiene in the Era of the Sustainable Development Goals: Synthesis Report of the WASH Poverty Diagnostic Initiative. WASH Synthesis Report*. Washington, DC: World Bank.

World Bank. 2017b. Climate Change Knowledge Portal (CCKP). http://sdwebx.worldbank.org/climateportal/

World Bank. 2018a. Pakistan Water Security Diagnostic. (forthcoming).

World Bank. 2018b. *World Development Indicators*.

World Bank. 2018c. *Strengthening Markets for Agriculture and Rural Transformation in Punjab (SMART Punjab – PforR): Technical Assessment*.

World Bank. 2018d. "Transforming Karachi into a Livable and Competitive Megacity: A City Diagnostic and Transformation Strategy." Directions in Development—Infrastructure; Washington, DC. Available at: https://openknowledge.worldbank.org/handle/10986/29376

WSTF (Water Sector Task Force of the Friends of Democratic Pakistan).2012. *A Productive and Water-Secure Pakistan: Infrastructure, Institutions, and Strategy.*

Yale Center for Environmental Law and Policy, "Environmental Performance Index." Available at: https://epi.envirocenter.yale.edu/epi-country-report/PAK

Yu, Winston, Yi-Chen Yang, Andre Savitsky, Donald Alford, Casey Brown, James Wescoat, Dario Debowicz, and Sherman Robinson. 2013. *The Indus Basin of Pakistan: The Impacts of*

Climate Risks on Water and Agriculture. Washington, DC: World Bank. doi: 10.1596/978-0-8213-9874-6.

Zahid, Maida and Ghulam. Rasul. 2012. "Changing Trends of Thermal Extremes in Pakistan." *Climatic Change* 113 (3–4): 883–896. https://doi.org/10.1007/s10584-011-0390-4.