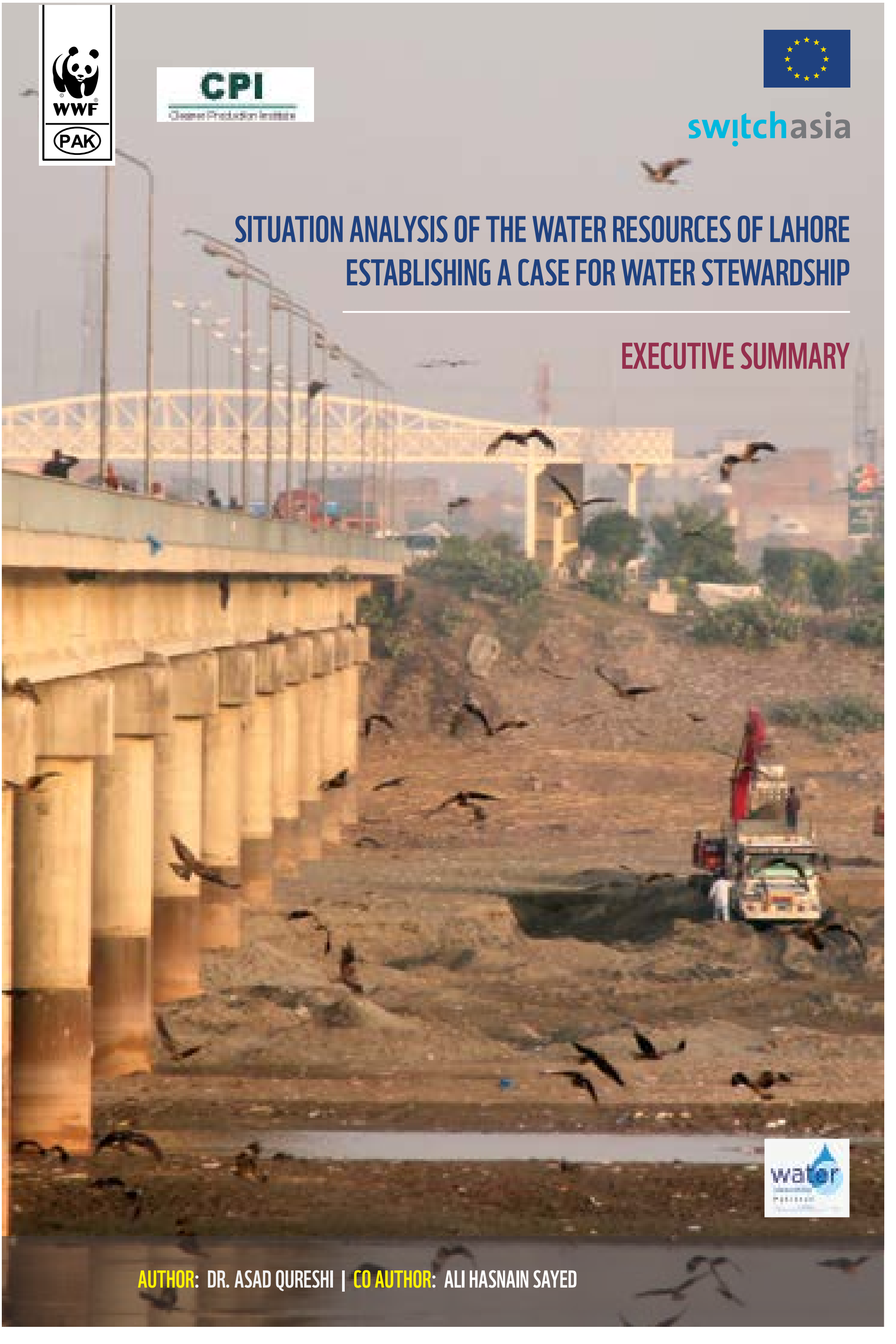

SITUATION ANALYSIS OF THE WATER RESOURCES OF LAHORE
ESTABLISHING A CASE FOR WATER STEWARDSHIP

EXECUTIVE SUMMARY

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Dr. Asad Qureshi holds a PhD degree in Water Resources Management from the Wageningen University, Netherlands. He has extensive experience in agricultural and urban water resource management in South-Asia, Central Asia and Middle East. He has long been associated with projects which involve technical, economical and socio-political aspects of surface and groundwater management and impact evaluation of water user associations in Pakistan and Central Asian countries. Most recently he was a team member of the USAID funded project which developed Master Plan for the Peshawar city for 2032. He has managed projects covering irrigation management, drought management, conjunctive water management, management of salinized and waterlogged soils, groundwater management, climate change and adaptation, impact assessment of irrigation infrastructure development, water user associations and wastewater management. He also served as Country Head of IWMI offices in Pakistan, Iran and Central Asia.

Dr. Qureshi was also member of the USAID led Future Harvest Consortium to Rebuild Agriculture in Afghanistan (FHCRAA), which prepared report on "needs assessment for land and water rehabilitation in Afghanistan". He has over 120 publications (journal papers, conference papers, project reports etc.) covering all aspects of water, environment and climate change management.

CO-AUTHOR'S PROFILE

Ali Hasnain Sayed is an Engineer by education and a development practitioner by profession. He holds a master in Environment and Sustainability from Monash University, Melbourne Australia. He has gained thirteen years of professional experience both in Pakistan and abroad, gaining a extensive practice in the fields of environment, law, water-food- energy security nexus, education, policy management, sustainable development and resource management. He has dynamic professional training from around the globe. Ali has been associated with governments, bureaucracy, civil society, corporate sector and regulatory regimes on mainstreaming developmental issues at the policy level. Currently with his job at WWF – Pakistan, he is practicing and professing Policy level environmental and developmental considerations and safeguards regarding to water – food – energy security nexus.

He has been involved in trainings and academics since 2005. He was one of the founding members and instructor at Sui Northern Gas Pipelines Training Institute in 2005. He has taught at Monash University, Australia and is currently teaching as a visiting faculty at Forman Christian College (A Chartered University) and a part of the team which is setting up the environmental science department at the University.

WWF-Pakistan, in collaboration with Cleaner Production Institute (CPI) and WWF-UK has launched a European Union funded project, entitled "City-wide Partnership for Sustainable Water Use and Water Stewardship in SMEs in Lahore, Pakistan". The project aims to contribute towards improving environmental sustainability and livelihood, and support sustainable economic growth and development in Pakistan. An important component of the project was to conduct a study, namely "Situation Analysis of the Water Resources of Lahore: Establishing a Case for Water Stewardship". The scope of this study includes comprehensive water accounting for city of Lahore, including description and volumetric quantification of all significant water sources, stores, and discharges, sinks and losses. The study has collated and presented information on

- The local and regional climate change scenarios and their likely impact on water resources
- River Ravi and groundwater hydrology of the catchment of Lahore's water resources
- Water quality issues including identification of key sources of pollution
- Water abstraction, consumption, trends in water use and water balance by different sectors
- Institutional and technical operation of the municipal water and waste water infrastructure in Lahore and how it is linked to wider policy context including plans for new infrastructure
- Strategies for future management and mitigation

The project aims to contribute towards improving environmental sustainability and livelihood, and support sustainable economic growth and development in Pakistan.

This report has also identified gaps in current knowledge at present and analyzed the collated information in order to identify the key water risks at the city level and problems and challenges faced by Lahore both in terms of water quantity and quality. A root cause analysis has been used within the report to pinpoint the specific factors that would need to be addressed by the city-wide partnership in order to mitigate the identified risks. The output of this study is a comprehensive report that will act as an authoritative reference document for the city-wide partnership and other interested stakeholders on the wider water context of Lahore.

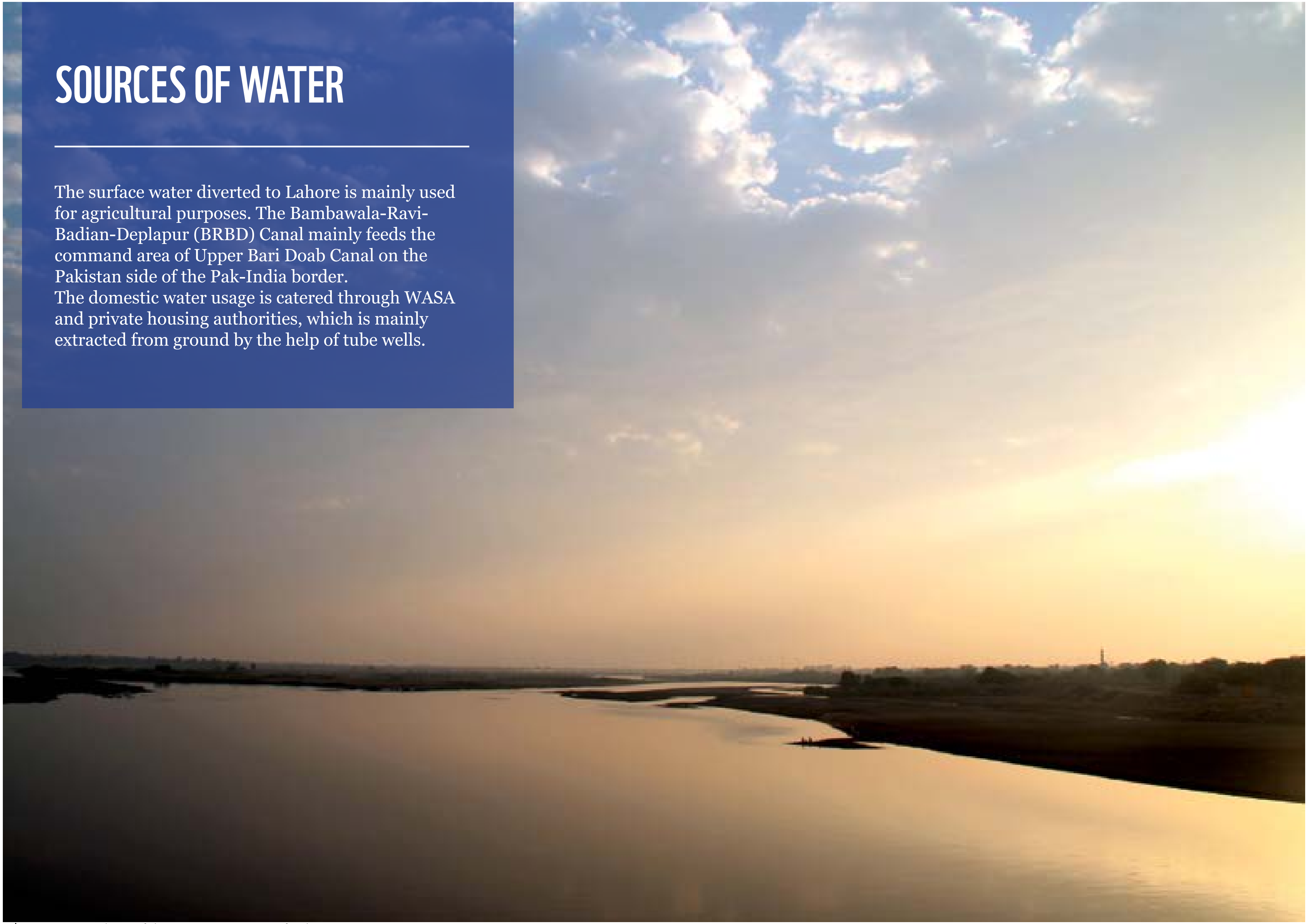
In the context of global climate change, rapidly rising population and urbanization across the developing world, water scarcity is increasingly viewed as the arena in which these variables will play out with potentially disastrous future social and environmental consequences. Pakistan is one of the countries which could face severe food and water crises as we advance in the 21st century. Due to increased competition for water resources by domestic and industrial sectors, major cities in Pakistan are already facing acute shortages of water. This has resulted in groundwater over-extraction, deteriorated water quality and extensive decline of groundwater-tables. Corporate water users increasingly perceive water scarcity, quality degradation and floods as direct business risks whereas indirect regulatory and reputation risks arise when water becomes a shared resource with communities and ecosystems. Institutional factors, such as weak regulation and governance, are often identified as significant contributors to the manifestation of these risks. An integral component of the project is building a city-wide partnership consisting of SMEs, public authorities, chambers of commerce, industrial associations, supporting institutions, and MNCs in order to ensure sustainable management of the city's water resources. WWF-Pakistan believes that engagement with these sectors is vital to consolidate support for the project and its aims and objectives. A core group consisting of stakeholder organizations will be formed which would serve as the initial steering group responsible for defining the terms of reference of the partnership and the decision-making approach.

Corporate water users increasingly perceive water scarcity, quality degradation and floods as direct business risks

This project aims at providing an authoritative reference document, for use by stakeholders and participants of this project to develop a water stewardship strategy. This report provides basic information about the physical water and institutional water management situation and risks (physical, reputational, regulatory and institutional) of Lahore, and provides a robust evidence base to support the identification and implementation of water stewardship activities.

SOURCES OF WATER

The surface water diverted to Lahore is mainly used for agricultural purposes. The Bambawala-Ravi-Badian-Deplapur (BRBD) Canal mainly feeds the command area of Upper Bari Doab Canal on the Pakistan side of the Pak-India border.
The domestic water usage is catered through WASA and private housing authorities, which is mainly extracted from ground by the help of tube wells.



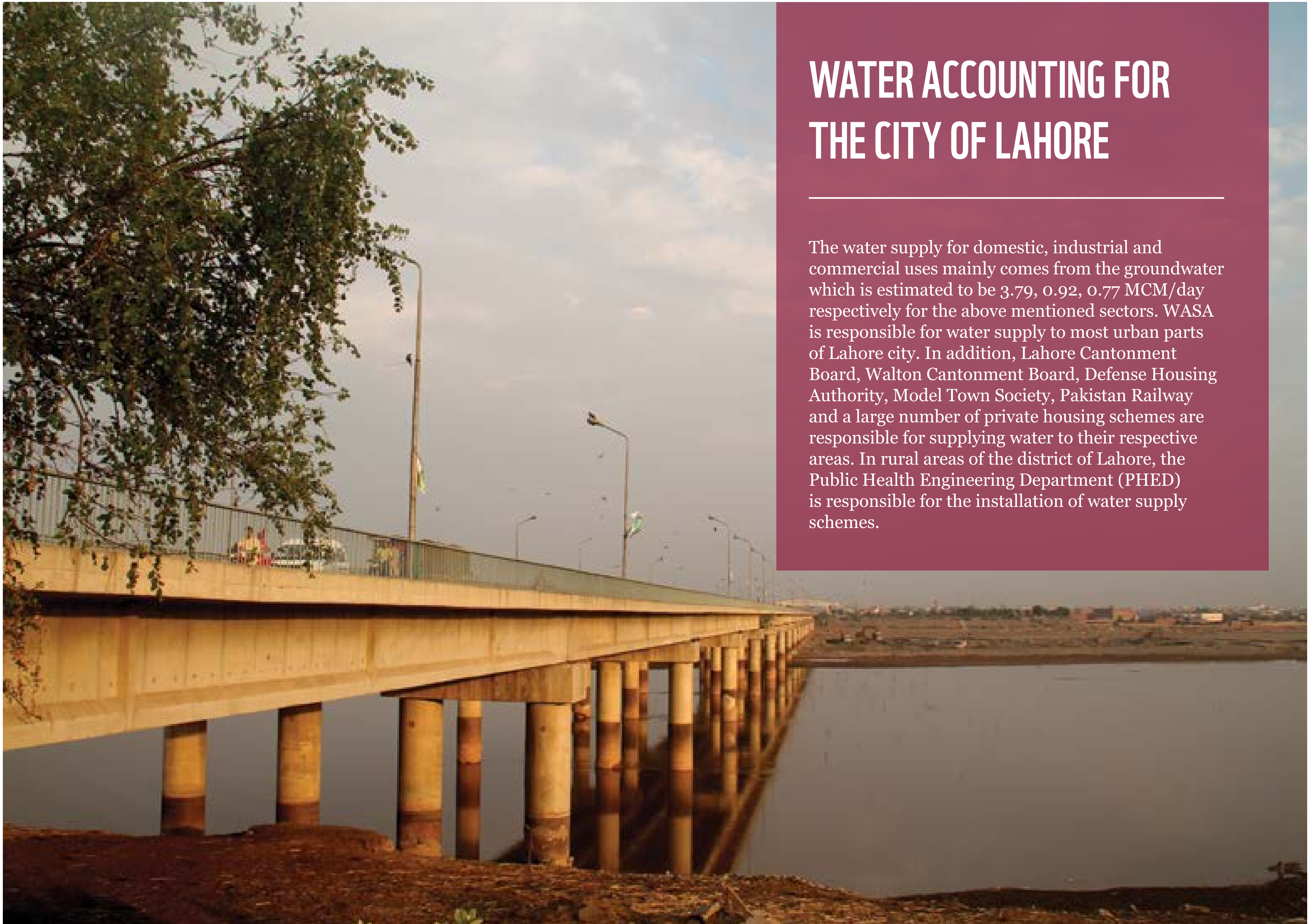
The Lahore aquifer is broadly viewed as a single contiguous, unconfined aquifer. Groundwater for drinking purposes is extracted from a depth of 120-200 metres (m). It is pumped for Lahore's domestic, industrial and commercial purposes. In order to deal with the vagaries of surface water supplies, more than 10,000 tube wells have been installed for agricultural purposes. The average annual rainfall of Lahore is 715 mm. However, its recharge to groundwater in urban areas is minimal due to urbanization. In general, groundwater discharge is higher than recharge, which is the main reason for the rapid depletion of groundwater in the city.

SOURCES OF POLLUTION AND QUALITY OF SURFACE WATER AND GROUNDWATER

The entire municipal waste from Lahore city is collected through a network of 14 main drains and discharged into the River Ravi without any treatment. The industrial waste is directly discharged into the canal system by 271 industrial units. These industries include textile, chemical, food processing, pulp and paper, poultry, dairy, plastic, paint, pesticides, leather, tanneries and pharmaceuticals. The second biggest source of pollution is the Hudiara Drain. Currently, there are around 100 industries located along the Hudiara Drain, which discharge wastewater directly into the River Ravi. Most of these industries are low-polluting, with 30–35 industries, categorized as high-polluting, including textile processing units, carpet industries, tanneries, food processing units and dairies.

The entire municipal waste from Lahore city is collected through a network of 14 main drains and discharged into the River Ravi without any treatment

In general, the groundwater quality is good near the River Ravi and gradually deteriorates in the south and south-western direction. Many studies have found higher arsenic levels (> 50 parts per billion) in pumped groundwater in Lahore. The quality of shallow groundwater is generally considered poor as these tube wells are adversely effected by seepage from sewerage/drainage systems. Since WASA extracts water from deep tubewells (> 200 m), the quality of pumped groundwater is relatively good. In the surrounding areas of Lahore, arsenic concentration is much higher than the WHO standard. The highly arsenic contaminated groundwater is found at shallow water-table depths of up to 30 m and the main anthropogenic source of arsenic is air pollutants derived from kiln factories, with fertilizers being a possible secondary source. Minor amounts of sulphate (SO_4) are also derived from air pollutants and fertilizers. Household wastewater also contains SO_4 but not arsenic.



WATER ACCOUNTING FOR THE CITY OF LAHORE

The water supply for domestic, industrial and commercial uses mainly comes from the groundwater which is estimated to be 3.79, 0.92, 0.77 MCM/day respectively for the above mentioned sectors. WASA is responsible for water supply to most urban parts of Lahore city. In addition, Lahore Cantonment Board, Walton Cantonment Board, Defense Housing Authority, Model Town Society, Pakistan Railway and a large number of private housing schemes are responsible for supplying water to their respective areas. In rural areas of the district of Lahore, the Public Health Engineering Department (PHED) is responsible for the installation of water supply schemes.

DOMESTIC WATER USE

WASA supplies drinking water to more than 6.0 million people by means of 484 tube wells. These tube wells are located in different areas and their depth varies between 150 to 200 m. Over time, water demand has increased from 180 litres per capita per day (lpcd) in 1967 to 274 lpcd in 2013. The total groundwater extraction from these 484 tubewells is about 2.2 million cubic metres per day (MCM/day). WASA tube wells run 14-18 hours per day and water is distributed from source to households through a network of 7,700 km long water supply lines and 600,000 connections. Only 78 per cent of households in the WASA serving area are connected to the piped water whereas in non-WASA areas this facility is available to 50 per cent of households. The remaining 50 per cent of households get water from hand pumps, public water stand posts or directly through groundwater pumping by using small suction pumps.

In the absence of any municipal water act or water-right law, groundwater is pumped indiscriminately by private housing schemes and industry. Private housing societies pump 0.37 MCM/day to supply water to their residents. In areas where the water supply network is not available, estimated extraction is 0.35 MCM/day. Therefore, the total groundwater extracted by private housing schemes is approximately 0.71 MCM/day. The water in rural areas of Lahore is supplied by PHED. There are 16 rural water supply schemes completed by the department. According to PHED, 13 out of these 16 schemes are non-functional due to non-payment of electricity bills. In conclusion, total domestic water use in Lahore is estimated at 3.79 MCM/day (1,384 MCM/year).

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INDUSTRIAL WATER USE

There are 2,700 registered industries in Lahore, out of which 75 per cent (2025) are categorized as large scale factories, which are the main users of groundwater. The textile industry makes up 20 per cent of the total industry and uses 69 per cent of the total industrial water consumption. Textile spinning, textile processing and textile weaving are the major consumers of water. The rest is shared by the chemical sector (10 per cent), the paper industry (5 per cent), the food industry (5 per cent) and other industries (11 per cent). Others include electronic, marble, leather, steel and paper industries. The analysis of this study shows that groundwater extraction for industries is in the order of 0.92 MCM/day (335MCM/year).

The total surface water diverted to Lahore for irrigation is 6.02 MCM/day

COMMERCIAL AND INSTITUTIONAL WATER USE

For commercial and institutional water uses (hospitals, educational institutes, mosques, shops and restaurants, public parks, offices, bus stands, railway stations and other similar places), WASA has provided 32,500 connections. Generally, water for commercial and institutional use is considered around 20 per cent of the domestic water use. Therefore, water usage for commercial purposes for Lahore city is estimated to be 0.77 MCM/day (277 MCM/year).

AGRICULTURAL WATER USE

The total surface water diverted to Lahore for irrigation is 6.02 MCM/day. However, water available for agricultural use is only 3.0 MCM/day as the rest is lost en-route as seepage from main and distributary canals, percolation losses from watercourses and farmer fields. In addition, about10,000 tubewells are also pumping groundwater for agricultural use. The total groundwater extraction from these tubewells is estimated to be 1.70 MCM/day (623 MCM/year).

COLLECTION AND DISPOSAL OF WASTEWATER

The wastewater generation in Lahore is estimated at 231 litres per capita per day (WASA Report, 2013). The total generation of wastewater is about 8.0 MCM/day and almost all is disposed of into the River Ravi without any treatment (JICA, 2010). Some industries discharge their wastewater on land or in soakage pits which results in groundwater pollution. For the disposal of wastewater, WASA has installed 12 major disposal stations with a total discharge capacity of 5.7 MCM/day. In comparison, the wastewater generation in Faisalabad is 3.0 MCM/day, out of which about 20 per cent is treated before being discharged into water bodies (Pakistan Water Operators Partnership, POWP, 2013).

The wastewater discharged into the River Ravi contains liquid and solid waste from domestic, industrial, and commercial premises, including but not limited to toilet waste, grey water (household wastewater of kitchens, bathrooms and laundries), sludge, trade wastes and gross solids. The Babu Sabu drain is the largest contributor of organic load to the River Ravi (154.7 tons/day) while Shahdara drain is the lowest contributor with only 3.27 tons/day. According to very conservative estimates, approximately 730 tons/day of Biological Oxygen Demand load is added to the River Ravi.

DISCHARGE AND RECHARGE TO GROUNDWATER

The total groundwater discharge from the aquifer for domestic, industrial and agricultural purposes is 7.17 MCM/day (2,619 MCM/year). Except for partial reliance of the agricultural sector on surface water resources, all other sectors (i.e. domestic, industrial and institutional) are totally banking on groundwater to meet their demands. The largest share (53 per cent) of this extracted water is consumed by the domestic sector. The industrial sector consumes 13 per cent, agriculture uses 24 per cent and the remaining 10 per cent is consumed by the institutional sector.The average recharge to groundwater is 6.50 MCM/day (2,372 MCM/year). The recharge from the River Ravi is estimated to be 1,937 MCM/year, from canals 148 MCM/year, from rainfall 137 MCM/year and groundwater return flow 150 MCM/year. Despite a reduction in Ravi flows due to upstream water use by India, the main recharge (82 per cent) to groundwater is contributed by the river. The rainfall and canal system contribute only 12 per cent whereas the return flow from irrigation fields is about 6.0 per cent. This shows the importance of Ravi flows in sustaining the Lahore aquifer.

The wastewater discharged into the River Ravi contains liquid and solid waste from domestic, industrial, and commercial premises

The overall water balance for Lahore and its aquifer is given in the table below.

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Components	Inflows	Outflows
Overall Water Balance		
River Ravi	0.00	
Canals (For Irrigation)	3.00	
Rainfall (Urban And Non-Urban)	3.46	
Contribution From River Ravi	5.31	
Contribution From Irrigation System (Main Canals And Distributary)	0.40	
Regional Groundwater Inflow	Unknown	
Runoff (From Rainfall And Other Sources) + Soil Storage		1.50
Evapotranspiration From Agricultural Crops		2.60
Wastewater Discharge To Ravi (From Domestic, Industrial And Commercial)		8.07
Total	12.17	12.17
Groundwater Balance		
Groundwater Recharge		
Recharge From Rainfall	0.38	
Return Flow From Irrigation Fields	0.41	
Recharge From River Ravi	5.31	
Contribution From Irrigation System (Main Canals And Distributary)	0.40	
Groundwater Discharge		
Groundwater Abstraction For Domestic Water Supply	3.79	
Groundwater Abstraction For Industries	0.92	
Groundwater Abstraction For Commercial And Institutions	0.76	
Groundwater Abstraction For Agriculture	1.70	
Total	6.50	7.17

Net Groundwater Balance (Discharge - Recharge) 0.67*

*This Shows That Daily Discharge From The Lahore Aquifer Is 0.67 MCM More Than The Daily Recharge. Therefore, On An Annual Basis, 247 MCM Of Groundwater Is Abstracted In Excess Of Groundwater Recharge Which Is Equivalent To 0.55 m Water Table Drop Per Year.

The difference between recharge and discharge is 0.67 MCM/day (247 MCM/year), which is equivalent to a 55cm (0.55m) per year drop in aquifer levels. In the 'business as usual' scenario, this value will increase further as the water demand will escalate owing to a rise in population. It should be noted that this water table drop is averaged over the whole Lahore district area. However, in urban parts of the city, the water table drop may be higher due to excessive pumping and insignificant recharge. In rural areas, where recharges from the irrigation system and agricultural fields are substantial, a decline in the water table may be less significant.

KEY PRESENT AND FUTURE WATER CHALLENGES

DEMOGRAPHIC AND SOCIAL CHALLENGES

The population of Lahore is expected to increase to about 22 million by 2025, out of which 84 per cent will most likely be living in urban areas. This massive increase in population during the next decade is expected to put enormous pressure on the water, sanitation, energy, transport, education and health sectors. Provision of housing will be a major problem in most urban areas. Inflow.

GROUNDWATER AVAILABILITY AND QUALITY CHALLENGES

Due to excessive pumping, the water table depth in the central part of the city has gone below 40 m, and it is projected that by 2025 the water table depth in most areas will drop below 70m. If present trends continue, the situation will become even worse by 2040, when the water table depth in a significant part of the study area will drop below 100m or more. Extraction of water from these depths will not be technically or financially feasible. With the persistent energy crises, groundwater pumping from excessive depths will be a huge economic burden on WASA and other organizations. In addition there will be a growing risk of deterioration of groundwater quality.

LOCAL AND REGIONAL CLIMATE CHANGE

The bulk of water of the Indus is derived from snow and ice melt. The western Himalayan glaciers act as a reservoir for the Indus basin, capturing snow and rainfall and releasing it into rivers that flow into the plains. Therefore, any changes in the available water resources through climate change or other human interventions will lead to serious challenges of food security and livelihood for millions of poor. Glacial retreat and changes in precipitation patterns from anthropogenic climate change are also expected to significantly alter river basin behaviour and jeopardize hydropower generation. Current water management practices may not be robust enough to cope with the impacts of climate change on a reliable water supply, flood risk, health, agriculture, energy and aquatic ecosystems. Improving water management will probably be the best strategy to cope with projected climate change. Public policy, so far dominated by mitigation, may benefit from a better balance between mitigation and adaptation. The development and introduction of climate adaptive measures will help reduce some of the potentially adverse climate impacts on food production and environmental degradation.

DEGRADING WATER INFRASTRUCTURE

Water availability in the Indus Basin is highly seasonal with 85 per cent of the total river flows occurring during the summer season (July-September). This makes storage critical for inter-seasonal transfer of water from surplus in the summer (kharif) season to meet shortages in winter (rabi) season to meet crop needs. It is estimated that the storage capacity of Pakistan reservoirs will be reduced by 57 per cent by the year 2025. The recent estimates suggest that to meet future water requirements, 22 BCM more of water will be needed. This will need to at least double the existing storage capacity.

Water availability in the Indus Basin is highly seasonal with 85 per cent of the total river flows occurring during the summer season (July-September).

The debate on small dams versus big dams in Pakistan has been going on for some time now. While small dams can be used to supply drinking water for rural communities, livestock, and production of fish, they have limited capacity to generate electricity. Large dams are considered feasible for the production of cheap energy but have serious social and environmental limitations. Therefore, Pakistan needs to introduce the concept of sustainable hydropower which essentially advocates integration of economic development, social development and environmental protection.

It is anticipated that by 2030, WASA will have to extend its services to 9.0 million people compared to 6.0 million in 2013

WATER-RELATED RISKS FOR INDUSTRY

Industries tend to face reputational, physical and regulatory risks due to water scarcity. Physical risks directly impact business activities, raw material supply, intermediate supply chain and product use in a variety of ways. The quality of water is critical in many industrial production systems, and contaminated water supply may require additional investment and operational costs for pre-treatment. Reputational risks are related to socio-cultural problems. Local conflicts can damage brand image, or in rare instances, even lead to a loss of operating license. Due to increasing pressure from civil society, companies may lose their licenses to use groundwater. These risks will increase as people become more aware of their rights to access water. Physical and reputational pressures affecting water availability and wastewater discharge can result in more stringent water policies. Water scarcity, coupled with increased concern among local communities about water withdrawals, will put pressure on local authorities and policymakers to consider water reallocations, regulations, and development of water markets that can usage, suspend permits to draw water and lead to stricter water quality standards.

WATER-RELATED RISKS FOR COMMUNITIES

It is anticipated that by 2030, WASA will have to extend its services to 9.0 million people compared to 6.0 million in 2013. This will increase the water demand to 3,200 MCM/year from a current level of 1,985 MCM/year and will require installation of 358 more tube wells by the authority, taking their total to 842. Similarly, the number of non-WASA tube wells will increase to 435 from the existing number of 240. Extensive groundwater withdrawal has formed a groundwater depression zone in the central part of the city where the water table has dropped below 40m. Continuous groundwater pumping from this depression zone is likely to induce a negative groundwater hydraulic gradient, which can accelerate the intrusion of saline groundwater from neighboring Raiwind and Pattoki areas where groundwater is saline. This would be disastrous for local communities and industries as there is no quick and simple way available to clean the polluted aquifer.

WATER-RELATED HEALTH AND ENVIRONMENTAL RISKS

Lahore is in constant danger of health and environmental risks and ecosystem challenges due to huge discharges of untreated domestic and industrial waste

Lahore is in constant danger of health and environmental risks and ecosystem challenges due to huge discharges of untreated domestic and industrial waste. The River Ravi is considered as the most polluted river among the main rivers in Punjab. Recent water quality monitoring has shown the presence of faecal coliforms in drinking water. Presence of toxic heavy metals in irrigation water, especially downstream of the River Ravi, is also causing serious damage to animal life in surrounding areas. A direct economic impact of untreated wastewater is the loss of fishery catches, which affects incomes and has nutritional and health impacts on consumers.
The use of contaminated surface water from Ravi for irrigation and recreational purposes is also replete with serious consequences as this will have a direct impact on the ecosystem and human health. In peri-urban areas of Lahore farmers are using untreated sewage/industrial water for vegetable production and water-related diseases such as typhoid, cholera, dysentery and hepatitis are very common. Evidence also shows that, in Lahore, vegetables and fruits grown with wastewater are also prone to heavy metal contamination.

Lack of coordination between inter-departments has been one of the major bottlenecks in successful and effective implementation of various management strategies.

INSTITUTIONAL AND ORGANIZATIONAL CHALLENGES

Despite existing laws to regulate groundwater, its excessive pumping continues throughout the city. LDA has not notified any areas where groundwater extraction should be restricted. Keeping in view the growing crises of groundwater and its consequences on the future of water supply for Lahore, these regulatory organizations need to enhance monitoring of groundwater abstraction and identify critical areas where groundwater extraction should be restricted.

In a changing environment, we need a different type of state machinery which has the vision and capacity to meet the challenges of urbanization, industrialization, recognition of environmental needs and climate change. For this to happen, we need to invest in institutions to enable them to take on future challenges. The capacity of institutions needs to be developed to undertake systematic sets of legislation and organizational changes to solve entitlement, pricing and regulatory issues. Reforms should also aim at solving management issues as well as delivering benefits to the people. Without these chances of success will be very limited.

Lack of coordination between inter-departments has been one of the major bottlenecks in successful and effective implementation of various management strategies. The roles and responsibilities of different organizations need to be clearly defined to avoid overlapping and to ensure effective management of water resources at all levels. The appropriate institutional arrangements are also needed for the formulation and evaluation of strategic options and monitoring implementation of national policies for the public water sector.

STRATEGIES FOR FUTURE MANAGEMENT AND MITIGATION

MANAGING AQUIFER RECHARGE

For proper management of aquifer recharge, we need to define groundwater protection zones according to the safe yield of the aquifer.

This can help to implement policy instruments such as a ban on boreholes and dug wells, defining the limits of withdrawal, imposing groundwater extraction fees, etc. Groundwater protection zones can be classified according to the level of vulnerability to groundwater extraction and should be protected from potentially polluting activities, viz. urbanization, solid waste dumping and chemical disposal, mining and quarrying. In Lahore, for example, central parts of the city where a groundwater depression zone is being developed should be defined as a "groundwater protection zone" and pumping should be regulated. Since groundwater plays an important role in economic development, the government needs to develop a strategy for long-term sustainability of this resource. Agriculture and industry depend heavily on groundwater, so policies dealing with agriculture and industrial development must try to incorporate the impacts of climate change on groundwater resources.

The importance of groundwater resources and the potential impacts of climate change on them should be discussed with all water users and stakeholders including government staff. All stakeholders need to be educated about the importance of groundwater to ensure sustainable management of its resources. Providing education and training to local communities about rainwater and runoff water harvesting for domestic use, agricultural use and for groundwater recharge will enhance the adaptation options to cope with current and anticipated future problems.

WASA should take measures to control demand by reducing per capita water availability by educating households to use water more wisely

BALANCING DISCHARGE AND RECHARGE

To protect quantity and quality of groundwater resources, the following suggestions may be helpful:

- WASA should take measures to control demand by reducing per capita water availability by educating households to use water more wisely.
- For long-term sustainability of drinking water supplies, the possibility of supplementing groundwater supplies with surface water supplies should be explored, wherever possible. For Lahore, provision of surface water supply from the River Ravi or BRBD canal system may be considered after addressing quality concerns.
- New housing societies should also be made aware of the problem and their groundwater extraction quota should be fixed based on specified per capita demand.
- To increase recharge to groundwater, rainwater harvesting should be encouraged in all new and old housing schemes and in areas currently under WASA jurisdiction. For this purpose, special recharge zones may be developed to facilitate groundwater recharge. While doing so rights of downstream water users must be protected.
- In order to promote the culture of water conservation, a metering system should be introduced to charge water on a volumetric basis. This will help in reducing water use, in the same way as is being done for electricity, gas and other utilities.
- WASA, LDA and EPA should enforce environmental laws to restrict industries not to dispose of their waste in drains, canals or other water bodies without treatment.
- Water should be treated as an economic good and its exploitation rights be given through a proper permit system and compatible prices especially to the industrial sector. At the same time, existing environmental laws need to be implemented seriously.

PROTECTING SURFACE WATER AND GROUNDWATER QUALITY

Water pollution can be reduced by eliminating contaminants at source which is the most effective way to protect water quality

Water quality challenges need to be addressed in an integrated manner and by adopting pollution prevention strategies. Water pollution can be reduced by eliminating contaminants at source which is the most effective way to protect water quality. The prevention of pollution at source is a cost effective solution as less money is required on waste handling, storage, treatment, remediation, and regulatory monitoring. Industrial units need to recycle wastewater generated from one process into other processes if it satisfies water quality standards.

Despite looming water challenges, businesses and investors are largely unaware of water-related risks and do little to develop strategies to cope with this challenge in future

Water quality solutions include:

- Regular monitoring of water quality. For this purpose, capacity of institutions (staff, laboratories, technologies, finances) should be enhanced.
- Water quality rules and regulations should be enforced in order to prevent the discharge of untreated effluents from industries and municipalities.
- An appropriate solid waste management system should be introduced to prevent the dumping of solid waste into water bodies and leachate generation.
- A sustainable pollution control strategy needs to be devised in order to reduce wastewater volumes. This approach may include the segregation of wastewater streams, process modification techniques and recycling and reuse of wastewater.
- Proper education and awareness campaigns about the importance of water-quality need to be launched. Media and non-governmental organizations (NGOs) can play a vital role in this aspect.
- An integrated water resource management approach should be adopted by involving all stakeholders for the protection of water quality. The linkage between research and development needs to be strengthened.
- Intelligentsia/academia should be encouraged to conduct research on finding indigenous low-cost water treatment solutions for the industry

MANAGEMENT STRATEGIES FOR INDUSTRIES

Despite looming water challenges, businesses and investors are largely unaware of water-related risks and do little to develop strategies to cope with this challenge in future. Keeping that in perspective, WWF-Pakistan with the support of the European Union is implementing a project City Wide Partnership for Sustainable Water Use and Water Stewardship in SME's of Lahore – Pakistan. The project is geared towards water cooperation by facilitating effective water resource management in SMEs of Lahore and adjoining areas thus trying to formulate a mechanism of water cooperation between the public and private sector to become active stewards of water by taking into consideration future supply chain risks. This project is expected to contribute to improving environmental sustainability and livelihoods and supporting sustainable economic growth and development in Pakistan. It will do so by supporting an improvement in the sustainability of production and consumption practices, with a particular focus on water use and water management in high water using, cross sectoral, urban based SMEs. The underlying cause behind the effort are the dynamics within water resources management which are changing with the entry of the private sector as corporate water users increasingly perceive water scarcity, quality degradation, competitive use by other sectors and flooding as direct business risks. The past few years has seen a radical increase in media and corporate recognition of the importance of water for society, economy and ecology, largely due to the increased understanding of the pressures and risks associated with Pakistan's freshwater resources. Corporate risk related to water is therefore an emerging issue and is likely to become more significant into the 21st century, due to increasing water stress internationally, investor perceptions and public awareness.

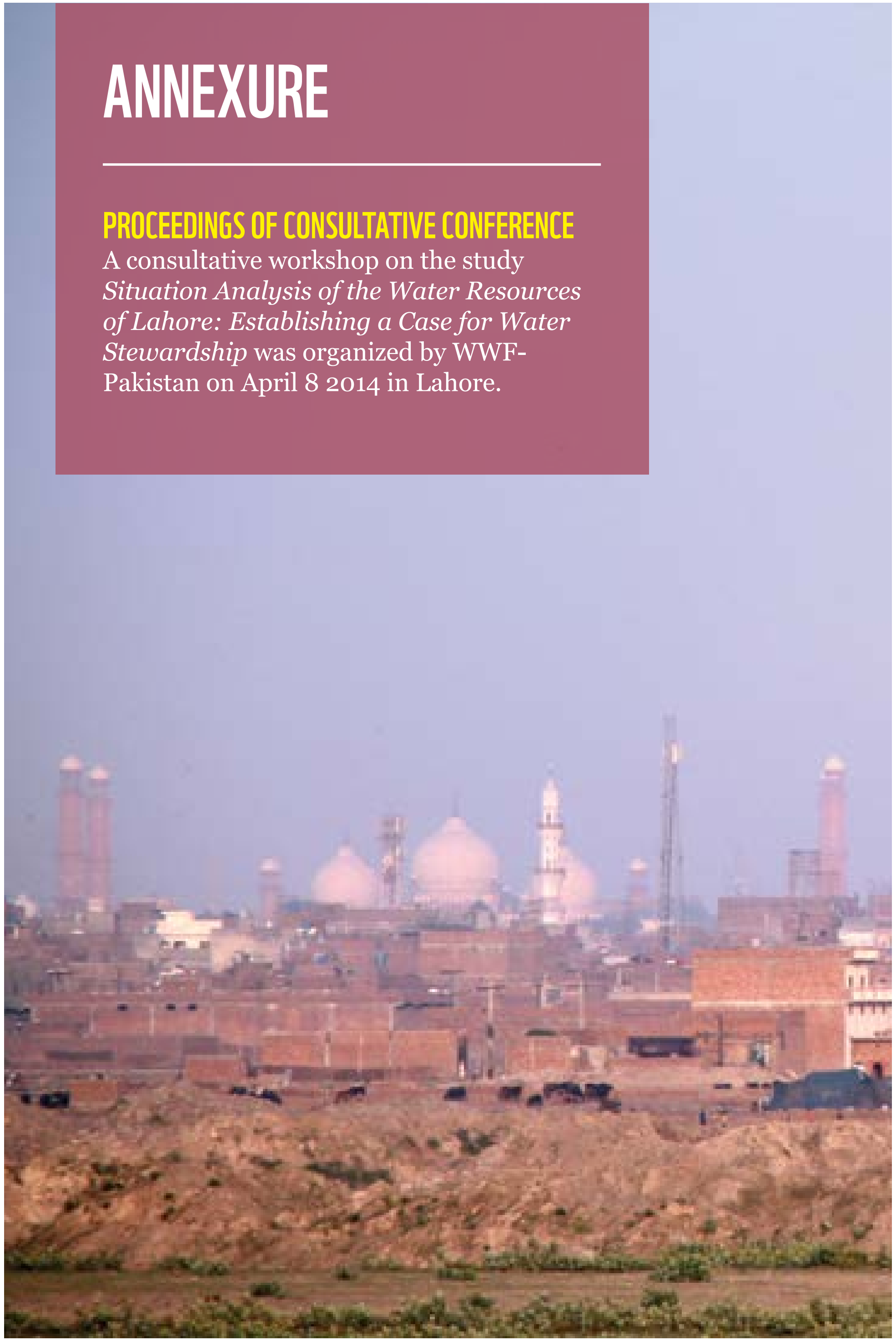
The following actions may help in the management and mitigation of water-related industrial risks in the context of Pakistan.

Companies need to be conscious of their water footprints (i.e. water use and wastewater discharge)

- Companies need to be conscious of their water footprints (i.e. water use and wastewater discharge) throughout their entire value chain, including suppliers and product use.
- Companies might assess their physical, reputational and regulatory risks and seek to align the evaluation with the company's energy and climate risk assessment.
- Engage key stakeholders (e.g. communities, NGOs, government bodies, suppliers and employees) as part of risk assessment, long-term planning and implementation activities.
- Industries can monitor their water resources and continue to develop strategies to maintain their water

reserves and adopt management practices geared towards creating efficiency per unit of production.

- Industries can invest in treating wastewater at source and reuse it. This will build up their reputation in society and help in avoiding future water risks.
- To promote water conservation in the industrial sector, attention must be given to water intensive sectors such as textile processing, paper and pulp, leather and tanneries, sugar etc. because this is by far the most water consuming industries in the region. Freshwater use is in the textile sector can be reduced by 30-50 per cent by modernizing the processing sector, which accounts for 72 per cent of the total water used in textiles. Water conservation is also important to address environmental concerns of global textile buyers.



ANNEXURE

PROCEEDINGS OF CONSULTATIVE CONFERENCE

A consultative workshop on the study *Situation Analysis of the Water Resources of Lahore: Establishing a Case for Water Stewardship* was organized by WWF-Pakistan on April 8 2014 in Lahore.

WASA and LDA need to implement laws for the installation of private tube wells in the city and in private housing schemes

The study is a part of WWF-Pakistan's on-going project "City-wide partnership for sustainable water use and water stewardship in SMEs in Lahore-Pakistan" funded by the European Union. The objective of the workshop was to share the findings of the study with a panel consisting of officials from the Environment Protection Agency (EPA), Land Reclamation and Irrigation Department, Lahore Development Authority (LDA), Pakistan Council of Research in Water Resources (PCRWR), NESPAK, WASA, Nestle, Cleaner Production Institute (CPI), International Water Management Institute (IWMI), Government College University (GCU), Lahore and Associated Consulting Engineers Consultancy Participants were invited to give their feedback on the study.

On the occasion, Dr Asad , (Water Management Specialist,)highlighted that conspicuous gaps exist in data generation and coalition on the water resources of Lahore. He further added that since the domestic sector is the major water consumer in Lahore, there is a need to reduce per capita water consumption in order to achieve water conservation. He requested government officials to step-up and shoulder the responsibility of conserving the water resources of Lahore. The consultative workshop was followed by a vigorous discussion session among the participants.

The following points were thoroughly discussed in this meeting:

- Water conservation measures should be adopted at all levels. WASA should introduce a metering system to make people aware about water issues.
- WASA and LDA need to implement laws for the installation of private tube wells in the city and in private housing schemes to control the fast declining water tables.
- A large amount of domestic waste is thrown into the River Ravi without any treatment. As the domestic waste is less polluted compared to industrial effluent, it may be re-used to irrigate city parks to reduce its volume for disposal into the River Ravi.
- The city government should install treatment plants at disposal points so that wastewater can be treated before being thrown into the River Ravi.
- Polluting the River Ravi would be catastrophic as this is the biggest source of drinking water for the population of Lahore.
- Water should be treated as an economic good and its availability to industrial and other commercial sectors should at a proper cost with the promise that they will not pollute the water for downstream users.
- Industries should be made responsible for treating their waste and should restrict discharge into water bodies. Industries stress that treatment is very expensive and the government should cooperate with the private sector to facilitate treatment of waste.
- WASA and other organizations should increase their capacity to collect wastewater from the city and treat it. The government should provide them with enough financial and technical resources to fulfil these tasks.
- Relevant data collection and its accessibility to relevant organizations were also discussed and the need to increase cooperation between different organizations was emphasized.
- Mass awareness campaign should be initiated to make people, the industrial sector and policymakers aware of increasing surface and groundwater problems in the city, both in terms of quantity and quality.
- To address water management and governance problems, some type of forum should be formulated including technical advisers, policymakers, representatives of media and civil society. WWF may take the lead in setting up such a forum with the help of other government and non-government organizations and relevant industries.
- Participants expressed a keen interest in future collaboration with WWF-Pakistan on water-related issues. They emphasized the need of a city-wide partnership for successful movement on water conservation in Lahore, which was appreciated and exemplified by all stakeholders.

Mass awareness campaign should be initiated to make people, the industrial sector and policymakers aware of increasing surface and groundwater problems in the city.

- Re-using Lahore's wastewater for landscaping purposes was discussed as well as the scope of constructed wetlands to promote biological water treatment and groundwater recharge.

LIST OF ATTENDEES

Sr. No	Name of attendee	Organization
1	Dr. Asad Sarwar Qureshi, Senior Environmental Consultant	National Development Consultants
2	Zamil Ali	Pakistan Council of Research in Water Resources
3	Muhammad Dilshad Arshad	Pakistan Council of Research in Water Resources
4	Arif Anwar	International Water Management Institute
5	M. Tariq Yamin	Directorate of Land Reclamation, Irrigation Dept., Lahore
6	Dr. Abdullah Hanan	Directorate of Land Reclamation, Irrigation Dept., Lahore
7	Faisal Nadeem	NESTLE
8	Zeeshan Suhail	NESTLE
9	Riaz Hussain	Lahore Development Authority
10	Zeeshan Yasin	NESPAK
11	Ajmal Nadeem	Environment Protection Agency Punjab, Lahore
12	Wasim I. Rabbani	National Environmental Consultant
13	Shakeel Ahmad Kashmiri	WASA, Lahore
14	Dr. Javed Iqbal	WASA, Lahore
15	Dr. Engr. Abdullah Yasar	Sustainable Development Study Centre, GCU Lahore
16	Akram Khan	World Health Organization
17	S. Nihal Asghar, Consultant	SEAL/RRC
18	Dr. Inayatullah	Bee Well Hospital
19	Sameen Khokhar	Associated Consulting Engineers (Pvt) Ltd.
20	Husnain Yasin Malhi	Associated Consulting Engineers (Pvt) Ltd.
21	Dr. Ejaz Ahmad	WWF-Pakistan
22	Ali Hasnain Sayed	WWF-Pakistan
23	Sohail Ali Naqvi	WWF-Pakistan
24	Durray Shahwar	WWF-Pakistan
25	Saba Dar	WWF-Pakistan
26	Saima Mian	WWF-Pakistan
27	Sarah Ephraim	WWF-Pakistan

WWF-Pakistan was formed in 1970 to address the growing environmental and conservation issues in Pakistan.

WWF-Pakistan's Water Stewardship Project will contribute to improving environmental sustainability and livelihoods and supporting sustainable economic growth in Pakistan.

Design: Hassan Zaki

WWF-Pakistan is part of the global WWF Network, one of the world's largest and most experienced conservation organizations, with almost five million supporters in more than 100 countries.

The Water Stewardship Project aims to create broad awareness through enhanced understanding and sharing knowledge of the impacts of unsustainable water use.

WWF

Why we are here:

To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

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