CLIMATE CHANGE ASSESSMENT

I. BASIC PROJECT INFORMATION

Project Title:	Khyber Pakhtunkhwa Cities Improvement Project (KPCIP)
Project Cost (€ million):	€507.37 ($585 million equivalent) (ADB and AIIB share of the project cost)
Location:	Cities of Abbottabad, Kohat, Mardan, Mingora, and Peshawar, located in Khyber Pakhtunkhwa Province in Pakistan
Sector:	Water and other urban infrastructure and services
Theme:	Solid waste management, water supply and sanitation, urban green spaces
Brief Description:	ADB approved its first project readiness financing (PRF) in March 2019. With the PRF, Government of Khyber Pakhtunkhwa mobilized consultants to complete climate change assessments and reflected the assessment results into detail engineering designs ahead of the approval of the proposed Khyber Pakhtunkhwa Cities Improvement Project. The project includes the following major components, (i) improvement of water supply systems; (ii) improvement of sewerage systems with provision of sewerage treatment plants (STPs); (iii) provision of integrated solid waste management (ISWM) systems; and (iv) development of urban green spaces. Change climate will impact project components in all project cites as below: **Abbottabad:** Increase in precipitation, humidity, and temperature variations are key aspects of the climate change that would impact investments in Abbottabad. The high temperatures may lead to increased evaporation losses in the surface water sources and supply systems, deterioration of water quality and increase in peak water demand to be made available from the surface water sources and the network. Increased precipitation may also lead to flooding and may damage the infrastructure of ISWM facilities and impact the quality and quantity of leachate in the landfill site. **Kohat**: High temperature and increased precipitation in Kohat due to climate changes may increase water demand, decrease ground water availability, impacts waste digestion processes of the ISWM system and STP, and increase the risk of flooding. Extreme temperature is also expected to increase water demand for management of green spaces and selection of plants and trees to be planted in these spaces. **Mardan**: Climate change induced temperature increase is expected to increase water demand for green spaces and impact ISWM treatment processes. The proposed ISWM and STP will also be impacted by higher precipitation levels and possible flooding, that may be exasperated due to existing high ground water levels prevalent in Mardan. **Mingora**: Similar to Abbottabad, the high temperatures and increased evaporation may lead to increased water requirements for human and plants, impacting the capacity of the water-supply system and also the sustained availability of water from the surface source. Performance of ISWM system may also be curtailed due to high temperatures. Variations in rainfall intensity will increase flooding risks to all project investments. **Peshawar**: Increases in precipitation, urban flooding and possibly high winds are considered as the key potential climate change impacts for Peshawar city. The treatment processes of the ISWM, water demand for green spaces and drinking water supply source and demand could be impacted due to increase in temperature and variations in intensity and duration of precipitation.

[a] €0.867303 = $1.00 as of 15 October 2021.

Source**:** Asian Development Bank

II. SUMMARY OF CLIMATE CHANGE FINANCE

Project Financing		Climate Finance	
Source	**Amount** ($ million)	**Adaptation** ($ million)	**Mitigation** ($ million)
Asian Development Bank			
Ordinary Capital Resources (regular loan)[a]	380.000	25.700 (66%)	81.129 (66%)
Asian Development Fund (13) Grant	5.000		
Asian Infrastructure Investment Bank	200.000	13.240 (34%)	41.794 (34%)
Government[a]	65.000		
Total	650.000	38.940 (100%)	122.923 (100%)

[a] Currency of Asian Development Bank financing in € equivalent, where €0.867303 = $1.00 as of 15 October 2021.
Source: Asian Development Bank

III. SUMMARY OF CLIMATE RISK SCREENING AND ASSESSMENT

A. Sensitivity of Project Component to Climate or Weather Conditions and the Sea Level

Water supply schemes. High temperatures prevailing over long periods of time, including heat waves, could result in increased water demand and reduction/variation in sources of the water supply schemes. Increase flooding could impact intake structures and treatment facilities.

Integrated solid waste management. An increase in the intensity and frequency of heavy rainfall events could result in flooding events, impacting the landfill infrastructure, including the landfill cells getting flooded along with the access roads. Any composting piles could also get significantly affected by occurrence of floods at the ISWM site and increased temperature could impact the treatment process or quality of material used in the machinery and construction.

Sewerage and drainage systems including sewerage treatment plant. High precipitation levels and flooding could increase the water loads on the sewerage and drainage systems while the STPs could also get damaged or their operation significantly affected due to high rainfall and/or flooding events. Higher temperatures could also impact the treatment processes and materials used in construction and machinery.

Urban/green spaces. High levels of rainfall or on the other extreme, long periods of high temperature and potential heat waves could result in damage to the trees/shrubs and grasses and their water use.

B. Climate Risk Screening

Temperature increases and fluctuations

- For water supply networks, an overall increase in temperatures may lead to increased water demand and energy consumption along with water scarcity at source.
- Increased evaporation may impact surface sources of water.
- Water sources for green spaces and plantations can be affected due to lack of precipitation and long periods of high temperature.
- Biological treatment process may be adversely affected by high temperatures including composting, biogas plant and tricking filters processes.
- Material used for construction and machinery may need higher sensitivity to increased temperatures.

Increased precipitation with flooding risk

- Increased precipitation resulting in increased surface runoff that may enter landfill cells.
- Disruption of waste transportation to waste processing facilities due to flood vulnerability especially during heavy precipitation periods.
- Erosion of earthen structures within the landfill site in case of intense precipitation and increased run-off.
- Extreme precipitation events could cause increased dilution of wastewater in the treatment ponds.
- Increased precipitation will result in extra load on sewerage network, also because large part of existing network is combined sewerage/drainage network.
- Extreme precipitation events could make green places un-usable and could cause damage to its infrastructure, and trees and plantation on the site.

Strong winds/Windstorms

- Debris due to strong winds at waste processing facilities may damage or hinder waste processing, if waste is not properly covered during the entire process.

Climate Risk Classification: Medium

C: Climate Risk and Adaptation Assessment

The risk and adaptation assessment has been conducted based on the latest 5 global climate models (GCMs), review and analysis of secondary data on climatic patterns available from project design reports and climate risks vulnerability assessment (CRVA) studies for the project cities conducted using community participation approach, along with secondary literature review on climate assessments available for these specific cities. The key climate risks to the different project components are already explained in detail in Sections A and B.

Considering the scope of KPCIP subsector investments, the projected high temperature and increase in precipitation in the project area due to climate changes is expected to increase water demand, decrease ground and surface water availability, impacts waste digestion processes of the ISWM system and STP, and increase the risk of flooding of the project investments. Extreme temperatures are also expected to increase water demand for management of green spaces and selection of plants and trees to be planted in these spaces. To offset these risks in all subprojects, up to 10% allowance for increase in water demand was included as an increment in their design to ensure that the sources of water, treatment plants and networks designs are capable of meeting the incremental requirements. The drainage system and flood protection structure for the project include 25% allowance on top of highest flood-level, to make subprojects resilient to possible increased flooding due to climate change impacts. The sensitivity of the biological treatment process, the materials used, and plant species identified for green spaces have also been assessed against 1.5-degree centigrade rise in minimum and maximum temperatures (with some variation between cities). The marginal impact on the biological processes will be managed through the controlled operational environment that will be climate resilient. Similarly, the incremental increase in temperatures has been built into the selection/specification of construction material and machinery that will be used for the project. The overall cost for incremental measures for adaptation against climate change impacts is estimated at 4.9% of the project investment components ($25.700 million).

D. Climate Risk Screening Tool and/or Procedure Used

The government of Khyber Pakhtunkhwa undertook climate risk and vulnerability assessment (CRVA) of project cities. This was followed by a detailed and additional assessment of climate change impacts on all project component and incorporation of the recommended mitigation and adaptations measures in project design to make project investment resilient against climate change impacts. Out of a total of 31 GCMs assessed, the 7 models that performed relatively better in capturing the annual variations and absolute deviations in precipitation, were used. Due to the limited availability of variables at the daily resolution, 5 out of the 7 models were selected for further analysis.

In addition to this analysis ,other available secondary literature was also consulted. The projected precipitation rise predicted through different global climate models is higher in the southeastern districts (Abbottabad and Kohat) compared to the northern districts (Mardan and Mingora), and temperature rise is predicted more toward the north of the province. The projected increase in precipitation is between 18mm to 182mm, between 2021–2045 compared to 1981–2020. The one-day precipitation increases ranges between 1mm to 20mm. The maximum temperature shows a projected increase between 0.8°C to 1.5°C under different scenario/models. The minimum temperature shows a rise of between 1.1°C to 2°C using the same models.

Source**:** Asian Development Bank and Urban Climate Change Resilience Trust Fund.

IV. CLIMATE ADAPTATION PLANS WITHIN THE PROJECT (ADB Financing)

Adaptation Activity	Target Climate Risk	Estimated Adaptation Costs ($ million)	Adaptation Finance Justification
Sewage Treatment Plants			
Mardan	Rise in maximum and minimum temperature will increase water consumption requirements together with increase in sewerage capacity. Extreme precipitation (1-day and 5-day precipitation) is likely to become more intense and frequent, resulting in more intense floods. Increase in temperature and heatwaves are projected in future. Such increase in hot environment will rise energy consumption in administrative buildings.	0.795	▪ The potential increase in water requirement and subsequent rise in sewage quantities have been considered in sewers design. ▪ Allocations for incremental adaptations measure and related quantities have been included in the design and cost of the project. ▪ Considering future intense and frequent floods, adequate design of drains and flood protection works have been considered. ▪ Enhance design capacity of pumps have been considered to accommodate increased water due to changing climate. ▪ The proposal includes the cost for managing and treating 10% additional water due to increase in demand and 25% increase in maximum flood flows. ▪ The proposal also includes insulations of buildings roofs and walls to reduce energy consumption and to provide protection against heatwaves and warming.
Kohat		0.647	
Water Supply Schemes			
Abbottabad	Rise in maximum and minimum temperature will likely increase water requirement. Floods are likely to increase in future, therefore adequate flood protection is required in various cities. Climate change beyond the increase water demand, are also likely to impact sustained water availability from sources. This will require efficient management, conservation, and protection of available water by reducing losses and adopting to the climate change induced stresses on available resources.	3.255	▪ Climate resilient design has been carried out keeping 10% additional capacity in the water supply network and distributions systems. ▪ Water storages designs also have 10% additional storage capacity to mitigate water stress due to climate change in various cities. ▪ Additional cost has been allocated for extra excavation due to use of large diameter pipes compared to the standard design ▪ Flood protection and drainage designs account for 25%
Kohat		1.520	
Mingora		6.090	
Peshawar		1.061	

Adaptation Activity	Target Climate Risk	Estimated Adaptation Costs ($ million)	Adaptation Finance Justification
			increase in peak flood levels due to climate change ▪ Pumping capacities have been decided based on additional water requirement due to rise in temperature. ▪ Roofs and buildings design include insulations, which protects from heatwaves, and reduce energy consumption. ▪ To cope with enhanced water stress due to climate change that at one end will increased demand (higher temperatures) and at the other end reduce availability of water from source (increase in flows variations, increased treatment required for poor quality flood water, and increased evaporation from sources and network), the project has proposed improvement in water management (SCADA), and measure to reduce losses and promote efficient use (conservation) of water (metering the network and household connection). An estimated 50% of SCADA and metering investments in the water networks are taken as adaptation costs catering to the incremental impacts of climate change stress.
Urban Green Spaces Subsector			
Abbottabad	Rise in temperature will increase urban heat impacts, water demand of plants and green spaces. Increase in precipitation will rase flood risks.	4.600	▪ 100% cost of the green spaces plantations and related infrastructure is added as adaptation finance considering their role in absorbing flood water through increased unpaved green spaces and use of porous material. Use of reflective surfaces and green spaces will also reduce urban heat impact. ▪ The water supply for parks includes proposed incremental cost of between 2 to10% to cater for 10% increase in water demand due to climate change.
Kohat		0.620	
Mardan		1.800	
Mingora		0.550	
Peshawar		2.360	

Adaptation Activity	Target Climate Risk	Estimated Adaptation Costs ($ million)	Adaptation Finance Justification
			▪ Adequate protections have been considered in design of drains and flood protection schemes to cater for 25% increase in high flood levels due to climate change.
Integrated Solid Waste Management (Landfill Sites)			
Abbottabad	Increase in frequent and intense precipitation will enhance flood risks. Leachate collection system may need adequate capacity to accommodate future intense and frequent precipitation and resulting flows. In addition, energy consumption in administrative buildings will rise due to increase in temperature and heatwaves.	0.053	▪ Climate resilient drainage systems have been designed. ▪ Adequate flood protection works have been considered based on 25% increase peak flood level due to climate change. ▪ Leachate collection system has been allocated additional capacity to accommodate climate induced increases annual flows of 25%. ▪ The administrative buildings have been made resilient against heatwaves and warming, by including insulations in roofs and walls.
Kohat		0.039	
Mardan		0.053	
Mingora		0.026	
Peshawar		0.056	
Reforms and Capacity Building and Gender Mainstreaming			
Gender Mainstreaming for climate adaptation Climate adaptation centric capacity building	Rise in temperature will increase water demand and heat island effects. Increase in precipitation will rase the flood risks.	0.845 1.330	▪ The capacity building component is designed to include training of communities and water and sanitation company's staff in improving efficiency of operation and raising awareness and knowledge about adaptation, including reduction and management of waste, improved hygiene practices, water conservation, increasing green cover at community level and maintaining the efficacy of the drainage systems to reduce flooding. ▪ Project will be offering distinct scholarship program for climate change studies and gender mainstreaming for climate adaptation.
Total		**25.700**	

Source**:** Asian Development Bank

V. CLIMATE MITIGATION PLANS WITHIN THE PROJECT (ADB Financing only)

Mitigation Activity	Estimated GHG Emissions Reduction (tCO_2e/year)	Estimated Mitigation Costs ($ million)	Mitigation Finance Justification
ISWM			
Peshawar	102,386.000	26.800	The ISWM would ensure that: i. Material recovery facilities will greatly reduce waste quantities going to landfill site and will have major contribution towards reducing GHG emission. ii. Anaerobic biodigesters will convert organic waste into compost and biogas for use as fuel and conditioner. This waste processing will result in much less GHG emissions compared to open dumping or landfilling, as methane is 28 times more potent than carbon di-oxide. iii. Vehicle fleet and machinery deployment will enable rapid transportation and start of waste recycling before natural decomposition starts. decreasing GHG emissions through these efficiency improvement measure. iv. The proposed ISWM will produce RDF, which can be used in cement industries or burnt in incinerators to produces energy. v. Only the cost of those component of the ISWM system that have major contribution towards GHG emission reduction, have been included in mitigation cost, which mainly include waste treatment and collection systems and exclude the landfill site and related structures.
Mardan	31,621.000	10.190	
Abbottabad	41,913.000	10.270	
Kohat	33,831.000	12.650	
Mingora	39,296.000	3.420	
Water Supply Schemes			
i. Shift from Groundwater to Surface Water Extraction:			
Mingora	258.200	7.127	Availability and delivery of surface water supplies will eliminate or reduce groundwater use. The energy required for pumping will be conserved. With the use of surface water sources the average energy saving per year is estimated to be 456 MWh for Mingora and 365 MWh for Abbottabad, resulting in an overall saving of 821 MWh per year. Savings in energy will also reduce GHG emissions.
Abbottabad	206.600	1.122	
Installing new distribution network and SCADA	115.000	9.220	The NRW will reduce from 45% to20% through (i) installing new distribution network and deploying SCADA and water metering. This will reduce energy load and cost of pumping.
Urban Green Spaces Subsector			
8515 LED lights in all Green Urban Spaces	263.900	0.330	This includes the cost of energy efficient lighting which will minimize energy consumption and reduce emissions from replaced grid energy (annual energy savings are estimated to be 466.2 MWh)
Total	**249,890.700**	**81.129**	

GHG = greenhouse gas, ISWM = integrated solid waste management, kW = kilowatt, LED = light-emitting diode, MWh = megawatt hour, NRW = nonrevenue water, RDF = refuse-derived fuel, SCADA = supervisory control and data acquisition, tCO2e = tons of carbon dioxide equivalent.
Source: Asian Development Bank.