CLIMATE CHANGE ASSESSMENT

I. BASIC PROJECT INFORMATION

Project Title:	Xiangtan Low-Carbon Transformation Sector Development Program
Project Cost:	$345.88 million ($150 million, Asian Development Bank [ADB] and $195.88 million, People's Republic of China [PRC]), excluding policy-based lending of $50 million
Location:	Xiangtan City in Hunan Province, People's Republic of China
Sector:	Multi-sector; Water and Other Urban Infrastructure and Services; Energy; Information and Communication Technology; Transport
Theme:	Climate Change and Disaster Risk Management, Energy, Transport, Urban
Brief Description:	The Xiangtan Low-Carbon Transformation Sector Development Program includes: (i) a project loan to finance the physical and non-physical investment and capacity building in promoting Xiangtan's transition to a low-carbon, resilient, smart, and a livable city; and (ii) a policy-based loan to support reforms to reinforce the low-carbon transformation under the project loan, ensure high quality low-carbon infrastructure and system development in the long-run, and create right incentive mechanisms to elicit low-carbon behavioral transformation. The Program will have four outputs of which outputs 1, 2, and 3 will be under the project loan while output 4 will be supported by the policy-based loan. **Output 1: Low-Carbon and Resilient Infrastructure Transformation Demonstrated:** Physical infrastructure transformation with integrated design of cross-sectoral interventions will be demonstrated. Road infrastructure will be transformed to ensure seamless access to public mobility systems that are safe and inclusive to all, including children, elderly people, and persons with disability. Incorporating safety would support the shift to low-carbon modes of transport. Mobility system transformation includes: (i) installation of comprehensive bus priority lanes (63 kilometers) with improved bus stops, integrated with improved bicycle network and pedestrian facilities; (ii) school zone transformation for children's road safety at five primary schools; and (iii) street transformation for climate resilient and multi-purposed street for people. Deployment of 100 electric buses and the installation of 778 e-charging units at 30 locations will also lessen greenhouse gas (GHG) emissions and contribute to air quality improvement. The construction of the first Excellence in Design for Greater Efficiencies certified (EDGE-certified) hospital building in the PRC will demonstrate the integration of passive building design, clean energy technologies, and ecosystem-based adaptation (EbA) measures. Other infrastructure transformation includes: (i) retrofit of a run-down public building to be equipped with high energy and water saving features and appliances; and (ii) improvement of public facilities and other urban infrastructure at 20 urban communities showing practical ways to build a low-carbon, resilient, and livable Xiangtan. **Output 2: Information and Knowledge Platforms Established for Informed Decision Making and Behavior Changes enabled.** Physical transformation complemented by information and communication technology (ICT) and knowledge platforms will complete and sustain low-carbon transformations. Under this output, a number of sectoral ICT platforms will be installed or upgraded, and then, consolidated into a city-wide ICT platform. These are the: (i) intelligent transport system (ITS) that will be reprogrammed to prioritize people and public mobility systems, (ii) building energy management system to monitor and improve energy efficiency of 200 public buildings, (iii) community-scale energy and utility management system to optimize operational efficiency of over 1,300 companies, (iv) early flood warning system to monitor and analyze potential risks caused by fluvial and pluvial floods, and (v) environmental monitoring and assessment system. These platforms will enable better decision making and foster behavior changes towards low carbon technology (LCT).

	Output 3 is 'Capacity building and program management enhanced'; and Output 4 is 'Low-carbon transformation policy reforms initiated'.

Source: Asian Development Bank estimates.

II. SUMMARY OF CLIMATE CHANGE FINANCE

Project Financing[a]		Climate Finance		
Source		Amount ($ million)	Adaptation ($ million)	Mitigation ($ million)
Asian Development Bank				
Ordinary capital resources (regular loan)		150.00	12.04	83.87
Government		195.88	3.24	76.76
	Total	**345.88**	**15.28**	**160.63**

[a] Excluding policy-based loan of $50 million.
Source: Asian Development Bank estimates.

III. SUMMARY OF CLIMATE RISK SCREENING AND ASSESSMENT

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

Project components and their sensitivities to climate or weather condition:

1. The upgrade and modification of urban roads (road lane and bus stops modification for median bus priority lanes, cycling ways, sidewalks, and bus stops refurbishment) located within the flood-prone zone): Urban heat island impacts during extreme summer temperature could cause the surface material to disintegrate. Extreme rainfall could cause flooding in the streets within the flood-prone zone, which prohibit mobility on these streets.
2. New building construction of the 'Xiangtan First Traditional Medical Hospital': Extreme rainfall could cause flooding, which may cause disruption in power, gas supply, and accessibility of the hospital.

B. Climate Risk Screening

Following ADB guidelines, climate risks screening and initial assessment was carried out and identified the magnitude of climate risks and vulnerability of the existing infrastructure in Xiangtan. Xiangtan is a semi-tropical city. The annual mean temperature is around 17.8 degrees Celsius (℃). Rainfall in Xiangtan is concentrated in spring and summer, while the autumns are typically dry. Heavy rainfall events are often short in duration. Extreme precipitation events which result in flooding normally last between one to three days and usually occur between April and August, while the highest river levels occur between April and July, which is the design period for the dike/drainage infrastructure according to Hunan Hydro and Power Design Institute. Flood is identified as a major climate risk in Xiangtan.

Climate Risk Classification: **Medium**

C. Climate Risk and Adaptation Assessment

To gain better understanding of climate change in the context of Xiangtan City, SimCLIM for ArcGIS tool was applied. Data from the Coupled Model Inter-comparison Project Phase 5 (CMIP5) climate models for the area of this project were compiled and reviewed. The simulated climate data from the General Circulation Model (GCM) used in this assessment include both the historical baseline and future timeframes under both the RCP 4.5 and RCP 8.5 scenarios, respectively. The historical scenario covers the GCM precipitation data for a 55-year historical baseline period from 1950 to 2005, while the RCP4.5 and RCP8.5 scenarios include an 80-year projection period (2021 to 2100). The GCM model data for each period of time scale can be viewed as a statistical realization of that climatic period.

Xiangtan would have moderate impact of climate change on extreme events. Mean temperature would change very little from current levels by 2050. Precipitation amounts for each return period event increase but only by a small percentage by 2030 and 2050. Temperature extremes do increase and return periods shorten but extreme temperature already occur with a one in 50-year event becoming a one in five-year event. Extreme cyclone wind speeds change very little through to 2050 and risk from wind events changes very little from current risk levels. A critical issue for many sectors is flooding and inundation. The impact is more significant on the intensity of heavy rainfall and storm events than annual precipitation, which may result in higher flood peak flows and impose higher flooding risks to the project components. More detailed

assessment was done for pluvial flooding, which involved the analysis of flood hazards, damage sensitivity, assessment of the required retention, detention, and/or storage capacity against floods, analysis of the applicability and feasibility of adaption measures; and stakeholder discussion to obtain feedbacks and preferences on those measures.

Data on many different aspects of the physical environment were assessed, including land elevation, land use data, soil properties, rainfall intensities and evaporation data and future climate change projection. Then, a hydraulic model relating to urban ecological baseline in Xiangtan was set up and the pluvial flood hazards map was developed for a rainstorm with a 100-year return period. Risks are defined as results of the probability of failure and the potential damage that would occur. Potential damage is defined by the damage sensitivity of people, objects and networks; however, no data exist on flood damage sensitivity in the relevant existing urban areas. Thus, by using the flood hazard map with the map of the future land use, Storage-Discharge-Frequency (SDF) curves were developed to assess the relationship between the required retention, detention, and/or storage capacity, and drainage capacity, its land use, soil type and the acceptable return period of flooding. In addition, the team of experts carried out specific site visits for potential selection of project component for resilience improvement for the Xiangtan project.

Earlier, urban drainage systems and water sensitive urban design were the main focus for resilience improvement, nowadays, a concept of green or blue-green infrastructure was introduced. Here, so-called EbA measures that integrate the use of biodiversity and ecosystem services emerged as measures to advance climate resilience, at the same time to maximize co-benefits. These can mitigate drought, reduce urban heat stress, provide aesthetic quality, recreational, and restorative capacity, and benefits health. With focus on EbA measures, the 'Xiangtan Climate Resilient City Toolbox (XCRCT)' was developed, where all the flood assessment results in Xiangtan are embedded. The toolbox is a touch-table based platform that design participants may use to select specific EbA measures in identified project areas, and immediately see an estimated resilience capacity improvement and the associated costs for implementation. The expert provided the training on climate resilience improvement, EbA measures, and the XCRCT, and facilitated the XMG's collaborative planning and decision making to determine detailed EbA measures in the two project areas – Fuxing Middle Road and Xiangtan First Traditional Chinese Medicine Hospital.

D. Climate Risk Screening Tool and/or Procedure Used

Climate risk screening and initial assessment was done using data from the Coupled Model Inter-comparison Project Phase 5 (CMIP5) climate models General Circulation Model in forecasting climate change and SimCLIM for Argis. Initial assessment identified the flood is the most critical climate risk in Xiangtan, especially pluvial flood. Thus, a detailed assessment study was carried out with focus on pluvial flood, which identified flood-prone zones. These assessment results were incorporated in the development of the customized XCRCT. Details are provided in a supplementary document on 'climate risks and vulnerability assessment'.

Source: Climate Risk and Vulnerability Assessment for Xiangtan Municipality.

IV. CLIMATE ADAPTATION PLANS WITHIN THE PROJECT

Adaptation Activity	**Target Climate Risk**	**Estimated Adaptation Costs** ($ million)	**Adaptation Finance Justification**
Install absorption bricks in 6.1 kilometers (km) pedestrian walkways of urban districts	Increasing rainfall intensity can result in flooding on urban roads	$3.08 (ADB: $1.54)	Over 6 km of absorption bricks will be installed in urban pedestrian sidewalks.
Install extensive ecosystem-based adaptation (EbAs) measures at Fuxing Middle Road	Increasing rainfall intensity can result in extreme flooding as flood-prone urban road	$4.67 (ADB: $4.67)	Raingarden, permeable pavement, ecological parking lots, tree-pit, sentinel catch-pits and newly built catch-pits will be carefully designed and installed.

Adaptation Activity	Target Climate Risk	Estimated Adaptation Costs ($ million)	Adaptation Finance Justification
(identified flood-prone zone)			
Install extensive ebAs measures at Xiangtan First Traditional Chinese Medicine Hospital (identified flood-prone zone)	Increasing rainfall intensity can result in extreme flooding as a critical flood-prone area	$0.89 (ADB: $0.50)	Raingarden, permeable pavement, urban wetland, green area, sentinel catch-pits and newly built catch-pits will be carefully designed and installed in the premises of the hospital building.
Integrated Urban Catchment Management Plan and Design Development for the Railway Station Block and Yangmaizhou Island	Increasing rainfall intensity can result in extreme flooding especially in critical flood-prone areas	$2.10 (ADB: $2.10)	Comprehensive fluvial and pluvial flood modelling, flood hazards assessment studies, geotechnical surveys will be carried out and site-specific Integrated Urban Catchment Management Plans will be developed for three critical flood prone zones.
Early Flood Warning System	Increasing rainfall can cause both fluvial and pluvial floods	$4.55 (ADB: $3.23)	Early flood warning system will integrate real time hydrological and hydraulics monitoring data with river catchment, urban drainage, and risk assessment models. It will quickly process large amounts of data and provide rapid forecasting models to provide necessary information for decision making.

Source: Asian Development Bank estimates.

V. CLIMATE MITIGATION PLANS WITHIN THE PROJECT

Mitigation Activity	Estimated Average Annual GHG Emissions Reduction (tCO_2e/year)	Estimated Mitigation Costs ($ million)	Mitigation Finance Justification
Mobility system transformation and clean bus deployment and infrastructure enhancement	263,251 (Total of 5,265,028 between 2026–2045)	$72.37 (ADB: $38.54)	City-wide urban bus priority systems covering over 60 km and upgrading sidewalks and cycling ways to be safe and inclusive will result in significant mode shift effect from cars to public and/or non-motorized transport modes.
EDGE-certified 'Xiangtan First Traditional Chinese Medicine Hospital'	3,243 (total of 64,860 between 2026–2045)	$17.92 (ADB: $9.51)	Applying passive design, efficient water and energy saving systems will be installed.
Community-scale multi-energy and utility management system at JiuHua Industrial Zone	238,185 (total of 4,763,705 between 2026–2045)	$4.54 (ADB: $3.63)	Multi-energy and utility management system will be installed to cover over 1,300 enterprises in Jiuhua Industrial zone, which will lead to significant improvement of energy and resource efficiencies at the zone.

Mitigation Activity	**Estimated Average Annual GHG Emissions Reduction** (tCO_2e/year)	**Estimated Mitigation Costs** ($ million)	**Mitigation Finance Justification**
Energy saving and clean energy supply features at 20 low-carbon communities' demonstration	9,577 (total of 191,534.89 between 2026–2045)	$47.74 (ADB: $22.92)	Building insulation, natural gas support for cooking, installation of roof top solar hot water systems and solar PV panels, LED lighting for buildings and streets are the key measures.
Building energy management system to cover 200 public buildings	7,863 (Total of 157,256 between 2026–2045)	$5.73 (ADB: $3.44)	Building energy management systems will be installed to monitor electricity, water, and gas consumption in 200 public government buildings, which will result to significant improvement in energy and resource efficiencies.
EDGE-certified building retrofit	566 (Total of 11,325 between 2026–2045)	$12.33 (ADB: $5.83)	Retrofit will have passive design, energy and water saving features to achieve 20% less energy use, 20% less water use, and 20% less embodied energy in materials compared to an average office building in Xiangtan.
Reprogramming ITS	26,325 (Total of 526,503 between 2026–2045)	0	It is assumed that 10% fuel efficiency will be gained by reprogramming the existing ITS to facilitate low-carbon mobility systems.

ADB = Asian Development Bank, EDGE = Excellence in Design for Greater Efficiencies, ITS = intelligent transport system, km = kilometer, LED = light emitting diode, PV = photo voltaic, tCO_2e = tons of carbon dioxide equivalent.
Source: Asian Development Bank estimates.