ECONOMIC ANALYSIS

A. Macroeconomic and Sector Context

1. The Yangtze River Economic Belt (YREB) is one of the three key economic growth engines in the People's Republic of China (PRC). Income inequality persists in rural areas of the less-developed middle and upper reaches of the Yangtze River basin. These areas lag downstream regions because of (i) weak institutional coordination for strategic planning, (ii) increasing pollution and pressure on natural resources, and (iii) slow transformation into green economic development.[1] The Asian Development Bank (ADB) and the government adopted a framework based on this plan to drive institutional strengthening; ecosystem restoration, environmental protection, and proper management of water resources; and green and inclusive industrial transformation.[2] The project is part of the YREB framework and will be implemented in the rural areas of Ganzhou.

2. Ganzhou is a large agricultural prefecture-level municipality in the Gan River watershed in Jiangxi Province. The project includes Nankang district and the counties of Chongyi, Dayu, Huichang, Ningdu, Shangyou, Shicheng, Xingguo, and Yudu. Ganzhou lags other municipalities in Jiangxi Province in terms of economic development, and has weak institutional capacity for environmental management. It has a population of 9.8 million and a land area of 39,380 square kilometers. Its total gross domestic product (GDP) in 2019 was CNY347.4 billion and its per capita GDP was CNY39,968, both of which fall below the national and provincial averages. Urban residents' average annual disposable income is three times that of rural residents.

3. The Gan River watershed has experienced substantial environmental and ecological degradation because of poor urban and rural sewage management—80% of rural sewage remains untreated, and solid waste tends to be dumped into water bodies. The water quality of Gan River in Ganzhou is rated Class III. The indicators of ecological degradation include unproductive wetlands and forests that have lost their capacity to attenuate erosion. Flood infrastructure and management systems are inadequate. Green agriculture technologies and practices to reduce nonpoint source pollution and advance green development are not widely applied. Ganzhou has no sustainable financing mechanisms for investments in water and air pollution control, green development, and improved livelihoods in rural areas.

C. Economic Rationale

4. There is a pressing need to improve the livability, health, and livelihood outcomes for an estimated 2.0 million rural residents in Ganzhou. The Ganzhou Municipal Government (GMG) is committed to providing better rural environments and tackling the ecological and environmental issues resulting from development and population growth. The project aims to help it achieve this by (i) creating green financing mechanisms, boosting capacity for green development, and raising the public's ecological awareness; (ii) improving rural wastewater and solid waste management; and (iii) reducing soil erosion and revitalizing rivers.

[1] Government of the PRC. 2016. *Outline of the Yangtze River Economic Belt Development Plan, 2016–2030*. Beijing.
[2] ADB. 2018. *Framework for the Asian Development Bank's Assistance to the Yangtze River Economic Belt Initiative: 2018–2020*. Manila

D. Demand Analysis

5. Demand assumptions were evaluated because benefit and cost calculations are a function of population growth. Project costs will depend on the project scale, while newly serviced households are beneficiaries of the investments.

6. A growth rate of 0.0% was assumed for rural villages, and 7.0% for central villages in towns or townships.[3] These rates reflect recent growth rates. Water supply, wastewater, and solid waste investments are based on these population growth assumptions combined with agreed per capita standards for system design, so demand forecasts are reasonable. The wastewater and solid waste components are designed to upgrade services for the rural population. New wastewater treatment facilities are all small-scale plants with capacities ranging from 300–2,500 cubic meters per day and servicing rural township settlements of 700–8,000 households. While most rural households have indoor flush toilets, they rely on poorly managed septic tanks. After project completion, the service connection rate will exceed 90%. Given the assumption of 0.0% growth in rural areas, the growth in benefits associated with all water supply, wastewater, and solid waste services is assumed to be 0.0%.

7. The calculation of benefits from better water quality reflects the willingness to pay (WTP) of benefiting households in the downstream urban area of Ganzhou. The annual urban population growth from 2013 to 2018 was 8.3%. Growth is assumed to be 0% for the urban population.

E. Economic Analysis

8. The least-cost and cost–benefit analyses for the project were completed in accordance with ADB's Guidelines for the Economic Analysis of Projects (2017).[4] The economic analysis was conducted separately for outputs 2, 3, and 4,[5] and for the overall project by comparing conditions with and without project.[6]

9. **Output 1: Institutional capacity and knowledge for environmental management enhanced**. The major aspects are environmental monitoring, project management support, and research. This output is not subject to economic evaluation, but costs are included in the overall evaluation.

10. **Output 2: Green development and financing mechanisms piloted.** This output focuses on the greening of agriculture while supporting rural livelihoods. First, a green financing mechanism will support small and medium-sized enterprises in agribusiness and crop production. Second, the project will introduce green farming practices, such as minimal use of chemicals and fertilizer, and will design green standards and traceability systems for organic products. Larger capital components include greenhouses, and integrated water and fertilizer drip irrigation. Third, 131 kilometers (km) of irrigation canals in 12 villages will be rehabilitated to resolve water and soil erosion problems that are causing production losses and ecological degradation. Finally, 11 villages frequented by tourists will be enhanced to promote ecotourism and rural economic development, including roadside afforestation and architectural restorations. This output will increase net farm incomes from the new greenhouses and generate revenues from tourist traffic.

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[3] China Statistics Press. 2019. *Ganzhou Statistical Yearbook, 2019*. Ganzhou (Tables 8–14, Statistics on Tourism).
[4] ADB. 2017. *Guidelines for the Economic Analysis of Projects,* Manila.
[5] Outputs 3, 4, and 5 involve pilot demonstration projects and capacity building.
[6] Details of benefit calculations are provided in Supplementary Document 19: Detailed Economic Analysis.

11. **Output 3: Rural waste and sanitation management improved.** This output will improve the quality of life for rural communities in Ganzhou. First, the project will introduce better domestic wastewater treatment and sanitation solutions and boost the rate of connected households to more than 90%. This will benefit 136,200 people (40,800 households). Second, better solid waste management will benefit 1,343,200 people (418,460 households). Finally, water supply will improve thanks to new water supply plants with a combined capacity of 25,000 tons per day that will serve 115,770 people (38,200 households).

12. **Output 4: Water and soil conservation practices improved.** Output 4 will mitigate flooding and improve the environmental quality of the Gan River watershed. The project will (i) rehabilitate the river environment by dredging the river, restoring the revetment, and building embankments along 132.51 km of stream; (ii) restore wetlands totaling 224 hectares (ha) and improve the infrastructure to protect them; (iii) strengthen water and soil conservation for 238 ha of productive tree cultivation (fruits, tea, walnuts, waxberry) and 1,512 ha of ecological trees; and (iv) reforest 10,200 ha by removing diseased trees, planting new ones, and install fire protection.

F. Least-Cost Analysis

13. A qualitative comparative analysis was completed for the subprojects to compare the cost effectiveness of various subproject design options. The preferred options were chosen based on relative costs and technical and environmental performance.

G. Cost–Benefit Analysis

14. **Project costs.** The economic costs include (i) capital costs of civil works, equipment, materials, land acquisition and resettlement, capacity development, and project implementation support; as well as social and environmental monitoring costs; and (ii) the cost of operation and maintenance (O&M). The project investment costs are listed in Table 1. The annual O&M costs during project implementation were estimated as 1% of investments in civil works.

Table 1: Summary of Investment Costs
(CNY'000)

Outputs	Financial	Economic[a]
Output 1: Institutional capacity and knowledge for environmental management enhanced	1,218,829	1,145,571
Output 2: Green development and financing mechanisms piloted	1,043,767	1,008,350
Output 3: Rural waste and sanitation management improved	587,844	543,947
Output 4: Water and soil conservation practices improved	1,196,345	1,119,694
Total Project Cost	**4,046,785**	**3,817,562**

[a] Costs exclude price contingencies and financing costs. Economic costs reflect adjustments with conversion factors.
Source: Asian Development Bank estimates.

15. **Project benefits.** The project benefits are all incremental. Eight types were considered, i.e., benefits from (i) wastewater service, (ii) improved water supply, (iii) improved solid waste management, (iv) improved health, (v) improved water quality, (vi) wetland and forest investments, (vii) green agriculture, and (viii) tourism. First, wastewater service benefits are realized by villagers who receive new wastewater services and are calculated based on the WTP. Estimated household WTP is CNY16.4 per month or CNY197.0 per year. This value measures the net WTP for improvements and represents the net benefit or consumer surplus.[7] Second, benefits for

[7] Supplementary Document 19: Detailed Economic Analysis. Annex 3, pp. 24–25.

households from improved water supply are valued based on the WTP for service improvements using a benefit transfer approach. Estimated household WTP is CNY33.4 per month or CNY401.0 per year.[8] Third, benefits for households from improved solid waste management are also valued based on the WTP for service improvements using a benefit transfer approach. Estimated household WTP is CNY27.3 per month or CNY327.0 per year.[9] Fourth, improved health benefits for villagers are valued based on total avoided annual costs of CNY593 per household (health care, productivity, and mortality-related costs).[10] This measure of benefit involves double counting of the WTP for water supply and wastewater services, since estimated household WTP should reflect the value placed on improved health as well as other benefits such as convenience and cleanliness of the village environment. Health benefits are considered because villagers are not likely to be well informed about them. Based on estimated water supply and wastewater benefits, only one-third of household health benefits are included in the analysis to avoid double counting. Fifth, benefits from improved water quality occur because outputs 3 and 4 improve water quality, which benefits downstream urban residents who rely on the Gan River system for their water supply. The valuation of this benefit is based on the WTP using a benefit transfer approach. It is also based on research in Huaping County in northern Yunnan.[11] Estimated household WTP is CNY43.2 per month or CNY519.0 per year. This benefit is apportioned across outputs 2, 3, and 4 based on pollutant loading. Sixth, investments in wetlands and forests provide ecological goods and services other than enhanced water quality. These benefits are valued using unit values derived from published research. Wetland services are valued at CNY38,409 per ha[12] and forest services at CNY18,346 per ha (2020 price levels).[13] Seventh, green agriculture benefits were valued using a crop budgeting analysis for investments in greenhouses. This analysis considers the yields, crop prices, and production costs of existing and new crops, and accounts for cost, insurance, and freight (CIF) border prices and transport costs. Average net crop revenues from greenhouse operations were estimated to be CNY13,559/*mu* and crop revenues increase by CNY 8,435/*mu* over current crops. Finally, tourism benefits comprise increased net tourism revenue in the project counties resulting from project investments, estimated based on area tourism visitation and expenditure data. Current tourist activity translates into 13.6 million tourists per year spending an average of CNY1,080 per visit, of which 80% is assumed to represent net revenue to tourism operators.[14] Tourism traffic was conservatively assumed to increase by 1%, resulting in an annual increase of CNY146.9 million. This estimates the direct income benefit associated with tourism;[15] indirect and induced income effects were not estimated. Project components will also attenuate flood flows, but avoided flood damages were not estimated because of data limitations.

16. **Economic rates of return.** The net present values and economic internal rates of return

[8] Supplementary Document 19: Detailed Economic Analysis. Annex 3, pp. 27–28.
[9] Supplementary Document 19: Detailed Economic Analysis. Annex 3, pp. 25–27.
[10] Economic Assessment of Sanitation Interventions in Yunnan Province, PRC. A six-country study conducted in Cambodia, Indonesia, the Lao People's Democratic Republic, the Philippines, the PRC, and Viet Nam under the Economics of Sanitation Initiative in September 2012.
[11] H. Wang et al. 2013. WTP for water quality improvements in Chinese rivers: An empirical test on the ordering effects of multiple-bounded discrete choices. *Journal of Environmental Management,* Vol. 131, pp. 256–269.
[12] C. Tong et al. 2007. Ecosystem service values and restoration in the urban Sanyang wetland of Wenzhou, China. *Ecological Engineering,* Vol. 29, pp. 249–258; as cited in Supplementary Document 19: Detailed Economic Analysis, Annex 3, pp. 32–37.
[13] C. Shixiong et al. 2019. Difference in the net value of ecological services between natural and artificial forests in China. *Conservation Biology*. Vol. 00, No. 0, pp. 1–8; as cited in Supplementary Document 4, Annex 3, pp. 37–39.
[14] Variable operating costs of tourism operations are assumed to be 20% of total revenues.
[15] Y. Yang. 2018. Explaining regional economic multipliers of tourism: does cross-regional heterogeneity exist? *Asia Pacific Journal of Tourism Research*. pp. 15–23. Actual direct benefits will depend on these expenditures and the links between economic sectors as measured by an income multiplier that typically exceeds 2.0. This estimate is therefore very conservative since it implies a multiplier of 1.0.

were calculated for each output using the methods and parameters discussed above. A summary of results is in Table 2. The overall economic rate of return is 11.7%, indicating that the project is economically viable. Base case cash flows for the overall project are in Table 3.

Table 2: Summary of the Economic Evaluation

Output	**EIRR** (%)	**NPV** (CNY million)
Overall project	11.7	930.61
Output 2: Green development and financing mechanisms piloted	8.6	(37.61)
Output 3: Rural waste and sanitation management improved	15.4	337.24
Output 4: Water and soil conservation practices improved	21.6	1,547.85

( ) = negative, EIRR = economic internal rate of return, NPV = net present value.
Source: Asian Development Bank estimates.

17. **Sensitivity analysis**. Sensitivity analysis tested adverse changes in key variables and conditions. Four risks are considered: (i) a 10% increase in capital costs; (ii) a 10% increase in O&M costs; (iii) a 10% decrease in benefits; (iv) a combination of tests (i), (ii) and (iii); and (v) a 10% reduction in urban growth. A summary of sensitivity tests for the overall project is in Table 4.

Table 3: Economic Return Analysis for the Overall Project (CNY million)

Year 2021	**Capital Invest.**	**O&M costs**	**BENEFITS**									**Net Annual Value**
			WS	**WW**	**SW**	**Green Agric.**	**Tourism**	**WQ**	**Forest**	**Wet land**	**Health**	
2022	(1,243.1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(1,243.1)
2023	(1,150.8)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(1,150.8)
2024	(740.0)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(740.0)
2025	(363.5)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(363.5)
2026	(176.7)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(176.7)
2027	(143.5)	(15.0)	15.3	8.0	82.5	33.7	117.5	192.6	225.7	8.6	26.9	552.5
2028	0.0	(44.2)	15.3	8.0	82.5	33.7	117.5	192.6	225.7	8.6	26.9	666.8
2029	0.0	(54.6)	15.3	8.0	82.5	33.7	117.5	192.6	225.7	8.6	26.9	656.3
2046	0.0	(54.6)	15.3	8.0	82.5	33.7	117.5	192.6	225.7	8.6	26.9	656.3
Residual												1,368.5

() = negative, O&M = operation and maintenance, SW = solid waste, WS = water supply, WQ = water quality, WW = wastewater.
Source: Asian Development Bank estimates.

Table 4: Economic Internal Rate of Return and Switching Value

Sensitivity Test	**EIRR** (%)	**NPV** (CNY'000)	**Sensitivity Indicator**	**Switching Value** (%)[a]
Base Case	11.7	930.6		
(i) 10% increase in investment cost	10.7	610.8	0.89	129
(ii) 10% increase in operating cost	11.6	908.3	0.05	417
(iii) 10% reduction in benefits	10.5	508.8	1.01	(22)
(iv) Combination of (i), (ii), and (iii)	9.5	164.9	1.91	NA

( ) = negative, EIRR = economic internal rate of return, NA = not applicable, NPV = net present value.
[a] The percentage increase/decrease in costs/benefits to maintain an EIRR equal to 9%.
Source: Asian Development Bank estimates.

18. **Benefit distribution and poverty impact analysis**. The economic benefits generated from the project will be allocated to stakeholders. The distribution of costs and benefits among stakeholders relies on estimates of incremental benefits and costs generated by the main project outputs. The total net benefit is estimated to be CNY4,389.0 million. Low-income and poor households account for 0.37% of the beneficiary population. Based on the proportion of poor beneficiaries for each project output, the total benefit accruing to the poor is estimated to be CNY23.0 million, and the poverty impact ratio is calculated as 0.005.