



## 1. Project Data

**Project ID**

P128867

**Project Name**

Jiangxi Wuxikou Flood Management Project

**Country**

China

**Practice Area(Lead)**

Water

**L/C/TF Number(s)**

IBRD-82370

**Closing Date (Original)**

30-Jun-2019

**Total Project Cost (USD)**

100,000,000.00

**Bank Approval Date**

20-Mar-2013

**Closing Date (Actual)**

30-Jun-2020

**IBRD/IDA (USD)**
**Grants (USD)**

Original Commitment

100,000,000.00

0.00

Revised Commitment

100,000,000.00

0.00

Actual

100,000,000.00

0.00

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## 2. Project Objectives and Components

### a. Objectives

The Project Development Objective (PDO) of the Jiangxi Wuxikou Integrated Flood Management Project as articulated in the Project Appraisal Document (PAD, paragraph 13) was identical to that in the Loan Agreement (LA, page 5) and aimed to:



***"reduce the flood risk in the central urban area of Jingdezhen City through implementation of priority structural and non-structural measures, and contribute to establishment of an integrated flood risk management system for the City."***

Project beneficiaries included: (a) communities and entities located in the central urban areas of Jingdezhen City, with a population of some 480,000; (b) the entire city will benefit from clean energy from the Wuxikou hydropower plant, and from more reliable water supply; and (c) the ecosystem and communities downstream of Wuxikou dam will benefit from assured environmental flow (PAD, paragraph 14).

**b. Were the project objectives/key associated outcome targets revised during implementation?**

No

**c. Will a split evaluation be undertaken?**

No

**d. Components**

The PDO was supported by the following four components:

**1. Construction of Wuxikou Flood Control Scheme (appraisal cost: US\$114.86 million, actual cost: US\$120.62 million, of which IBRD financing was US\$79.84 million).** This component included the following four sub-components:

1.1. Construction of a concrete gravity dam on the main stem of the Changjiang River in Luoxi village, Jiaotan Township of Fuliang County about 40 km upstream of Jindezhen City with a maximum dam height of 46.8 m and crest length of 498.62 m, a gated overflow spillway with five gates and six bottom outlets, and a hydropower plant with a total installed capacity of 32 MW and annual power generation of 81,210 MWh.

1.2. Acquisition and installation of electro-mechanical equipment of 5 radial gates (each of 12 m x 6 m) for a 78 meter wide surface spillway and 6 plane gates for the outlets (each of 12 m x 9 m), two 15 MW and one 2 MW turbine-generator units, a switchyard and two transformers, and necessary equipment for the operation and maintenance of the dam.

1.3. Implementation of the Environmental and Social Management Plan (ESMP).

**2. Establishment of Integrated Flood Risk Management System (appraisal cost: US\$9.40 million, actual cost: US\$14.45, of which IBRD financing was US\$9.65 million).** This component included the following six sub-components:

2.1. Preparation of a master plan of integrated flood risk management for Jingdezhen City2.

2.2. Development of an integrated flood risk management decision support system, including a real-time flood forecasting and early warning system (modeling system) coupled with database, GIS and network technologies.

2.3. Construction of a municipal flood control and dispatching center, including design study, building construction to facilitate efficient functioning of the municipal flood management system.

2.4. Provision of equipment for a municipal flood control and dispatching center, including essential operation equipment to facilitate efficient functioning of the municipal flood management system.

2.5. Carrying out awareness raising and community engagement activities in integrated flood management



through, inter alia, carrying out of training and organizing seminars and workshops.

2.6. Provision of specialized technical training for integrated flood risk management for the purpose of raising awareness and engaging different interest groups on risk management and mitigation.

**3. Implementation of Resettlement Action Plan (appraisal cost: US\$384.61 million, actual cost: US\$418.29 million, of which IBRD financing was US\$99.75 million).** This component would carry out a program for the resettlement and rehabilitation of people affected by the implementation of the project, including: (a) Investment in resettlement, (b) Investment in special infrastructure, and (c) Reallocation of effected section of railway.

**4. Project Management and Implementation Support (appraisal cost: US\$2.39 million, actual cost: US\$2.76 million, of which IBRD financing was US\$2.08 million).** This component would strengthen the capacity of Jingdezhen City to implement and manage the project through: (a) Provision of consulting services to enhance engineering design, construction supervision, dam safety and environmental and social management, including the formation and maintenance of a Dam Safety Panel of Experts; (b) Carrying out of capacity building activities through workshops, training and study tours; (c) Establishment and operation of a monitoring and evaluation system, including a project management information system; and (d) Acquisition of office equipment and vehicles, and provision of operating resources.

**Additional Activities.** During the first restructuring, project savings were reallocated to finance new eligible activities identified during project implementation, and which were within the original project scope as follows:

Component 1: Reservoir site ecological restoration and relocation/protection of ‘ancient’ trees (US\$4.28 million).

Components 2 and 4: Patrol boats and video cameras for reservoir water-quality and city-area flood monitoring, as well as preparation of a flood contingency plan (US\$1.01 million);.

Component 3: Reservoir resettlement access road (US\$7.26 million, which was the only item added under Component 3 and was financed by the Bank loan).

#### **e. Comments on Project Cost, Financing, Borrower Contribution, and Dates**

**Project Cost.** The total project cost at appraisal was expected to be US\$513.17 million. Actual cost according to the ICR Data Sheet (page 2) was US\$586.93 million. The difference was due to an increase in counterpart funding (see below for more details).

**Financing.** The project was financed through an IBRD Flexible Loan worth US\$100 million based on a variable Reference Rate for the Loan Currency (6-Month LIBOR for US\$) plus an additional variable spread. The loan had a commitment-linked repayment in 25-year period, including a 6-year grace period, and level repayment of principal. According to the ICR Data Sheet (page 2) the loan was fully disbursed.



**Borrower Contribution.** The borrower was expected to contribute US\$413.70 million of counterpart funds. This amount was revised upwards to US\$498.69 million. The actual amount was US\$486.93 million (ICR Data Sheet, page 2).

**Dates.** The project was approved on March 20, 2013, and became effective four months later on July 19, 2013. The Mid-Term Review (MTR) was prepared on April 21, 2016 compared to an expected date on June 30, 2015. The project closed on June 30, 2020 compared to an expected closing date on June 30, 2019. According to the ICR (paragraph 23) the 12 months extension was "to allow Bank engagement to contribute to the satisfactory completion of the resettlement work." The project was restructured twice; both were Level 2 restructuring. The first restructuring was on April 25, 2019, when the amount disbursed was US\$82.55 million, in order to reallocate funds between disbursement categories. The second restructuring was on June 26, 2019, when the amount disbursed was US\$82.55 million, in order to extend the closing date by 12 months from June 30, 2019 to June 30, 2020.

### 3. Relevance of Objectives

#### Rationale

**Context at Appraisal.** Jingdezhen City, an industrial and cultural center in Northeastern Jiangxi, was very vulnerable to river flooding with its low ground elevation and very little flood control infrastructure. A major challenge for Jingdezhen City was to reduce the risks of frequent floods from the Changjiang River, a medium-sized river flowing through the downtown areas of the City. The project would provide necessary flood protection to Jingdezhen City through the implementation of priority structural and non-structural measures and would contribute to the establishment of an integrated flood risk management system for the City.

**Previous Bank Experience.** The Bank reflects global good practice on development of flood risk management systems, focusing not only on infrastructure construction but also on flood risk mitigation measures. Several Bank-supported projects in China involved Integrated Flood Risk Management would provide lessons and recommendations relevant to the preparation and implementation of this project. While, the PAD did not include a list of these projects nor their lessons that were reflected in the project design, the project benefited from the Bank's 2010 Policy Note recommendations for Chinese policy makers to develop integrated flood-risk management.

**Relevance to Government Strategies.** At appraisal, objectives were in line with the central government document on water resources issues entitled "Decisions on Accelerating Water Sector Reform and Development, (2011)" which proposed a strategy for establishing a comprehensive flood prevention system by 2020. The strategy required that flood control systems of small and medium-sized rivers in areas most vulnerable to mountain flash flooding should be strengthened by the end of 2015 (the end of the 12th five-year plan, 2011-2015). Objectives were also in line with strategy of Jingdezhen Municipal Government (JMG) to build a "Combined City Dike-Reservoir System" for the protection of Jingdezhen City from a 50-year flood event of the Changjiang River, specifically, the Wuxikou Flood Control Scheme, which includes



construction of a flood control scheme upstream in Fuliang County to upgrade the flood protection standard for the City from a 20-year flood event to a 50-year flood event.

At completion, objectives continued to be in line with the National 13th Economic and Social Development (FY16-FY20) which identified “constructing modern infrastructure systems” as a national priority and highlights the need to “promote integrated flood risk management in small and medium rivers” to enhance national water security. The 13th National Water Sector Development and Reform (FY16-FY20) and National Disaster Prevention and Reduction Plan (2016-2020) both emphasize the need to mainstream flood-risk management by improving forecasting and early warning systems and capacity as well as combining structural infrastructure interventions with non-structural measures, including integrative planning, enhancing institutional coordination, and improving community awareness and preparedness. At the provincial and local levels, objectives continued to be in line with both the Jiangxi Provincial Economic and Social Development 13th (FY16-FY20) and the Jingdezhen Municipal Economic and Social Development 13th (FY16-FY20) where both featured flood control enhancement, especially in small- and medium-river basins, as one of their development priorities.

**Relevance to Bank Assistance Strategies.** At appraisal, objectives were in line with the Bank’s China Country Partnership Strategy (CPS, FY13-16). Specifically, to Strategic Theme One: Supporting Greener Growth, Outcome 1.5 for Demonstrating Sustainable Natural Resource Management Approaches. The project would play an important role in the construction of essential water infrastructure and development of a flood risk assessment and management system to safeguard the livelihoods of the rural and urban poor.

At completion, objectives continued to be in line with Bank’s Country Partnership Framework (CPF, FY20-FY25). Specifically contributing to Engagement Area Two: Promoting Greener Development. Specifically, under Objective 2.5: Promoting Low-Carbon Transport and Cities, it stated that “through both ongoing and potential future operations, the Bank would help cities build resilience to natural disasters, especially floods; and support the shift in focus from natural disaster recovery and construction to introducing risk reduction in socio-economic planning (CPF, page 32).” Furthermore, the project also would directly contribute to Objective 2.4: Demonstrating Sustainable Natural Resources Management and Objective 2.1: Facilitating the Transition to a Lower-carbon Energy Path (CPF, page 45).

**Relevance to the United Nations Sustainable Development Goals (SDGs).** Objectives were in line with SDG#11: to make cities and human settlements inclusive, safe, resilient and sustainable. Specifically, the project would contribute to the achievement of Target 11.5: By 2030, significantly reducing the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations. Objectives were also in line with SDG#13: to take urgent actions to combat climate change and its impacts, as the project would contribute to Target 13.1: to strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries. Objectives were also in line with SDG#7: to ensure access to affordable, reliable, sustainable, and modern energy for all, as the project would contribute to Target 7.2: by 2030, increase substantially the share of renewable energy in the global energy mix.



The statement of objectives was clear, realistic and achievable. The PDO also reflects an appropriate level of ambition given the Bank's experience and the country capacity. However as a result of the dam construction works, the project also achieved renewable energy generation, city water supply provision, watershed management and regulation, which were not part of the objective. These aspects could have been included as part of the PDO and RF.

Based on the the above-mentioned information, Relevance of Objectives is rated High. This rating reflects the close alignment of the PDOs with national and local development priorities, the Bank's CPS at appraisal and CPF at closure, as well as the United Nations SDGs.

## Rating

High

## 4. Achievement of Objectives (Efficacy)

### OBJECTIVE 1

#### Objective

PDO#1: To reduce the flood risk in the central urban area of Jingdezhen City through implementation of priority structural and non-structural measures.

#### Rationale

**Theory of Change (ToC).** To achieve the stated objective (to reduce flood risks in the central urban area of Jingdezhen), the project supported structural measures which were complemented by non-structural measures to improved effectiveness (see section 2 d for more details). Expected outputs included: integrated flood management plan approved, DSS developed and operational, Flood Control and Dispatching Center established and operational. The expected outcomes of these activities (structural + non-structural) included: reduction of flood risk in central urban area of Jingdezhen City, and establishing and integrated flood management system for the city. These outcomes were expected to contribute to longer-term impacts such as: a climate resilient, environmentally sustainable and economically efficient development for Jingdezhen City.

The project also included a dedicated component to resettlement. These resettlement activities according to the ToC were enabling conditions to achieve the project outcomes.

Key assumptions that underpinned the achievement of the PDO included: DSS operational with professional staff, Government commitment to sector development is maintained including financial sustainability, institutional development and coordination. These assumptions were reasonable.

Overall, the project interventions were closely linked to the outcome and intermediate outcome indicators, reflected clear operational logic and the key assumptions were logical.





## Outputs

The following outputs were reported by the ICR (Annex 1) unless referenced otherwise.

- The Wuxikou Flood Control Scheme was constructed with a dam length of 498.62 m, maximum dam height of 46.8 m, and a total reservoir storage capacity of 474.7 million m<sup>3</sup> and flood prevention storage capacity of 296 million m<sup>3</sup> (target achieved).
- Dam construction and safety plans were implemented as part of the dam safety safeguards (ICR, paragraph 82).
- Operation & Maintenance Plan for Wuxikou Flood Control Scheme approved and operational (target achieved).
- Installed hydropower plant of 32 MW (target achieved).
- Environmental flow and water supply provided for downstream (target achieved).

## Outcome

To reduce the flood risk in the central urban area of Jingdezhen City, the project completed the construction of the Wuxikou flood control scheme-which became fully operational since June 2019 (ICR, paragraph 35). The Wuxikou flood control scheme was used in combination with the city dike system to reduce flood risk. Flood protection was also reinforced by the establishment of an integrated flood risk management system for the city (PDO#2 discussed in detail below). By project completion, 0.48 million people out of 0.6 million total urban population in Jingdezhen in 2019 or 80% of the population were protected from 1-in-50-year floods (PDO outcome indicator #1, target fully achieved). According to the ICR (paragraph 31) "the indicator was measured as people living in the 50-year flood impact zones identified through model simulation. These impact zones were defined on the basis of flood-risk mapping and the number of people protected was identified on the basis of a detailed local census."

Also, the completion of the Wuxikou dam, in combination with the city dike system and flood forecasting and early warning systems, improved the flood protection level from 20-year flood to 50-year flood (target: 50 years, target achieved) (PDO outcome indicator #2), and the total area subject to inundation by 1-in-50-year floods was reduced to 3.56 km<sup>2</sup> compared to a baseline of 35.58 km<sup>2</sup> (target achieved, PDO outcome target #3). According to the ICR (paragraph 33) "this indicator is measured by comparing the flood hazard maps with and without the reservoir operation. According to the Integrated Flood Risk Management Master Plan developed under Component 2, the flood hazard map has been incorporated into the general urban planning and the land use for the remaining 3.56 km<sup>2</sup> has been restricted to non-essential activities and non-high-value properties."

The Wuxikou flood control scheme also included the installation of a hydropower plant with a total capacity of the 32 MW. According to the ICR (paragraph 35) this plant was put into use since May 2019. The establishment of the water reservoir behind the dam allowed maintaining a flow of 16.66 m<sup>3</sup>/s in 2019, (target: 15 m<sup>3</sup>/s, target exceeded) in the downstream according to the scheme's operational plan-which was sufficient to maintain the environmental flow as well as to provide water supply for Jingdezhen's downtown area (ICR, paragraph 38). This amount exceeded the minimum environmental flow (minimum water flows to maintain the ecological health of the river) for Changjiang River's mainstream which was determined at 8.87m<sup>3</sup>/s, 10% of the multi-year average. Before the project, the flow amount in the Changjiang River during



dry months could be as low as 2.78 m<sup>3</sup>/s. The reservoir was able to provide the city with an annual water supply of 26 million m<sup>3</sup> -Class II water quality (Class II water quality: In China, surface water quality is classified into five classes with Class I being the best and Class V being the worst. Water quality of Class II refers to good surface water quality that meets the criteria for drinking water source and natural habitats for valuable aquatic species, ICR footnote#17).

Finally, the effectiveness of the Wuxikou flood control scheme was put to test during the 50-year flood of July 2020. With 5.88 times more precipitation than the multi-year average during the period of July 7 to July 9, 2020, the Changjiang River experienced two large floods on July 7 and July 8. According to the ICR (paragraph 41) the 50-year flood peak of Changjiang River on July 8 was reduced to a 20-year flood level- which was successfully contained by the dike system in Jingdezhen City- designed to protect against a 20-year flood. The urban population was not affected and no areas were inundated due to fluvial flooding by the Changjiang River (ICR, paragraph 41). The total avoided flood loss was estimated to amount about US\$496.45 million, which was comparable to the estimated direct loss of US\$354 million during the 1998 floods (ICR, paragraph 47).

Based on the above-mentioned assessment, the efficacy of achieving this outcome is rated High. The rating reflects the successful completion of the flood scheme, and the successful handling of the July 2020 floods.

**Rating**  
High

## **OBJECTIVE 2**

### **Objective**

PDO#2: To contribute to establishment of an integrated flood risk management system for the City.

### **Rationale**

**Theory of Change (ToC).** To achieve the stated objective (to contribute to establishment of an integrated flood risk management system for the City), the project supported structural (discussed above) and non-structural measures. These included: adopting risk-based flood management approaches and developing an Integrated Flood Risk Management Master Plan; enhancing local flood management capacity and cross-sector flood management coordination by establishing a Flood Control and Dispatching Center and providing trainings to professionals; enhancing flood forecasting and early warning capacity by developing a Decision Support System (DSS); and improving community awareness and preparedness through Information, Education and Communication (IEC) activities. Reservoir operation (i.e., closing or opening flood gates to store or release water) would be informed by the DSS (non-structural measure) attenuates flood peaks and therefore reduces the economic losses to the downstream Jingdezhen City. Also, non-structural measures such as increasing community flood awareness and preparedness were also needed in order to cope with the greater flood risks associated with climate change and its effect on water variability and potentially increasing the frequency and severity of flooding. Finally, the combination of both structural and non-structural measures helped Jingdezhen achieve the PDO outcomes of reducing the flood risks in central urban areas.





Key assumptions that underpinned the achievement of the PDO included: DSS operational with professional staff, Government commitment to sector development is maintained including financial sustainability, institutional development and coordination.

Overall, the project interventions were closely linked to the outcome and intermediate outcome indicators, reflected clear operational logic and the key assumptions were logical.

## Outputs

The following outputs were reported by the ICR (Annex 1) unless referenced otherwise.

- Flood Risk Management Master Plan was approved and operational.
- Enhanced Flood Forecasting and Early Warning Capacity with a Flood Management DSS was developed and O&M Plan approved and operational.
- Increased community flood awareness and preparedness.
- Enhanced Flood Management Institutional Capacity with a Flood Control and Dispatching Center established.

## Outcome

The achievement of the second PDO#2 supports the achievement of PDO#1. The three PDO outcome indicators discussed above pertain to this outcome as well. According to the ICR (paragraph 30), these three outcome indicators were "an appropriate measure of both PDO outcomes since the two PDO outcomes reinforce each other." While this Review is in agreement with the ICR that the two PDO outcomes reinforce each other, yet the assessment of second PDO could have benefited from separate more specific indicators. For example, the extent of readiness of the integrated flood risk management system could have been assessed through a score matrix that covered different aspects including: awareness, capacity building activities, and coordination in-between different local authorities involved in flood management, among others.

The project followed the eight principles outlined in the Bank's 2010 Policy Note on Integrated Flood Risk Management- Key Lessons Learned and Recommendations for China. Specifically, "the project prioritized people and communities by increasing the percentage of urban population protected from 50-year floods (Principle 1); helping Jingdezhen City to move from flood control to flood-risk management and planning by developing an Integrated Flood Risk Management Master Plan, whose recommendations have been incorporated in the city's general urban planning and are already being implemented (Principle 2); promoting Integrated Watershed Management and Planning by developing a flood forecasting and management system at the basin-level (Principle 3); combining structural and non-structural measures (Principle 4); contributing to mainstreaming disaster risk management into overall urban planning (Principle 5); enhancing institutional coordination and cooperative planning by establishing a Flood Control and Dispatching Center (Principle 6, see paragraph 54); improving disaster preparedness and response by developing a Decision Support System and conducting IEC activities (Principle 7). Overall, the project contributed to both climate change adaptation and mitigation (ICR, paragraph 38)."

Specific achievements under this outcome included:

1. Development of DSS and approval of its O&M plan. The project established a DSS that combined a hydrological model with a hydraulic model, a reservoir operation optimization model, and a flood impact



assessment model. The DSS was developed two years before the project completion, allowing sufficient time for calibration and improvement. The DSS extended the early warning time by three hours in comparison to the traditional hydrological system used by the Jingdezhen Hydrological Bureau. This allowed more time for flood response, such as reservoir pre-discharge and emergency evacuation. The system also includes an urban drainage and pumping component, which was used to facilitate integrated management with the dike and reservoir system.

The O&M plan for the DSS was approved by JMG in June 2017; the system subsequently entered into trial operation in March 2018, and was then officially accepted by the Jingdezhen Municipal Water Affairs Bureau (MWAB), after one year of calibration and improvements, in March 2019 (Intermediate Indicator 7). At project closure, the system was fully operational and staffed by full-time professionals hired by MWAB and trained to operate the system. Before the 50-year flood event on July 8, 2020, the DSS informed Wuxikou Reservoir's pre-discharge as well as JMG's decision to evacuate more than 2,000 people overnight, protecting them from flood risks.

2. Increasing community flood awareness and preparedness. Specific activities for increasing community flood awareness and preparedness included: IEC, seminars, and education, rehearsal and motivation activities. A 1,000 people, both community members and officials in flood prone areas answered flood-risk awareness questionnaires. From April to July 2018, flood evacuation rehearsals were conducted under the project. Community flood awareness assessment was conducted in July 2018 and was subsequently formulated into brochures and other materials for distribution. By the time of project closure, the total coverage of those activities had reached more than 0.48 million people (about 0.24 million males and 0.24 million females, target: 0.44 million). On July 8, 2020, 2060 people were evacuated in Fuliang county in preparation of the projected flood peak on July 9 according to the procedures established.

3. Land acquisition and resettlement. The project successfully supported the 15,808 people adversely affected under it. Resettlement related impacts under the project were as follows: 10,469 persons (or 2,331 households) were physically displaced, of whom 9,402 19 permanently relocated to one of the resettlement sites and 1,067 moved into their houses in urban areas. The physically displaced households normally experienced permanent loss of land and other means of livelihoods including business. Additionally, 5,339 persons experienced economic displacement only, including permanent loss of livelihoods or businesses.

The evidence provided in the ICR point to the success of the project in establishing an integrated flood risk management system for the City. The efficacy of the stablished system was put to test during the July 2020 floods where the urban population was not affected and no areas were inundated due to fluvial flooding by the Changjiang River (ICR, paragraph 41). Therefore, the efficacy of achievement of this outcome is rated High.

**Rating**  
High

## **OVERALL EFFICACY**

### **Rationale**



Overall efficacy is rated High. This rating reflects the success of the project in reducing the flood risk in the central urban area of Jingdezhen City through implementation of priority structural and non-structural measures, and contributed to establishment of an integrated flood risk management system for the City. The rating reflects the successful completion of the flood scheme, and the successful handling of the July 2020 floods. In addition, the project generated a series of environmental and social co-benefits, including guaranteed environmental flows in the Changjiang River, hydropower electricity production, and improving urban water supply as a basic public service (ICR, paragraph 43). Finally, the development of dam site park would help promote tourism in the area (ICR, paragraph 61).

### Overall Efficacy Rating

High

## 5. Efficiency

### Economic and Financial Efficiency

#### *ex ante*

- The project economic rate of return (ERR) was estimated at 18%.
- Cost benefit analysis was carried out to assess the economic viability of the project. The principal project economic benefits are derived from the reduction in the expected future flood losses. Flood frequency and loss data were used to estimate losses under the Without Project and With Project situations, and the difference provides the expected economic benefit (saved costs) of reduced flooding. According to the PAD (paragraph 2) direct flood losses include landslides and flashfloods. However, the PAD did not discuss indirect flood losses. That said, indirect losses might include disruption of livelihoods, loss of jobs, disruption of transportation routes and supply chains, and health related impacts due to disruption of utilities.
- No sensitivity test was conducted as the analysis excluded non-quantifiable benefits.

#### *ex post*

- The project's economic rate of return (ERR) at completion was estimated at 20.6% compared to 18% at appraisal. The ICR (paragraph 45) noted that the estimated ERR was conservative given that the estimate of project benefits did not include the considerable indirect development benefits from tourism potential and resettlement. The economic analysis applied hydraulic model simulations based on the project-developed DSS to evaluate direct flood losses compared to a statistical methods used at appraisal.
- The project benefit analysis included two scenarios: with Wuxikou Reservoir Operation and without Wuxikou Reservoir Operation, under floods with recurrence intervals of 20a, 30a, 50a, 75a, and 100a, respectively. Economic losses in these 10 events, with five flood recurrence intervals under two scenarios. The Occurrence Exceedance Probability (OEP) curve was calculated based on the above simulations; and as a simplified assumption, the OEP curve was close to the Annual Exceedance



Probability (AEP) curve. According to the approximate AEP curve of flood losses, calculate the average annual flood loss expectation in the probability interval between 20-year floods (EP=0.189) and 100-year floods (EP=0.01) for the AEP curve in the two scenarios based on the price level in 2020; (6) by comparing the expected flood losses in the two scenarios, the average annual flood reduction benefits was quantified based on the price level in 2020.

- In 2020 the total avoided flood loss (including both direct and indirect losses) was estimated to amount about US\$496.45 million, which was comparable to the estimated direct loss of US\$354 million during the 1998 floods.
- The project's O&M costs were expected to fully covered as the annual revenues from electricity generated through hydropower amount to RMB 32.3 million, which was larger than the annual O&M cost of RMB 12.1 million.
- The ex post ERR analysis was detailed and robust and demonstrated the economic viability of the project.
- Actual costs of component 1 and 3 were slightly higher than appraisal costs for both components due to the inclusion of some extra activities (see section 2 for details).
- In a further communication, the project team explained that the "project economic analysis considers the future frequency of flood events based on historical data only while the frequency and severity of floods are expected to change in the future under a changing climate, whose estimation could benefit from climate change modelling."

## Administrative and Institutional Efficiency

The project closed 12 months later than expected on June 30, 2020. According to the ICR (paragraph 23) the 12 months extension was "to allow Bank engagement to contribute to the satisfactory completion of the resettlement work." Structural investments were completed on time in 20019 and the dam and the hydropower unit were both operational before completion. According to the ICR (paragraph 49) "the delay in resettlement did not affect reservoir impoundment or negatively impact the project achieving its outcomes on time."

Overall, efficiency is rated High. This rating reflects a higher ERR at completion compared to appraisal (20.6% compared to 18% and 8% discount rate). It also reflects the substantial economic benefits related to protection against the 2020 floods and future floods. The one-year delay was beyond the control of the project and did not impact the main structural investments.

## Efficiency Rating

High

a. If available, enter the Economic Rate of Return (ERR) and/or Financial Rate of Return (FRR) at appraisal and the re-estimated value at evaluation:

	Rate Available?	Point value (%)	*Coverage/Scope (%)
Appraisal	✓	18.00	100.00 <input type="checkbox"/> Not Applicable



ICR Estimate	✓	20.60	100.00 □ Not Applicable
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\* Refers to percent of total project cost for which ERR/FRR was calculated.

## 6. Outcome

Relevance of Objectives was rated High. Overall efficacy was rated High. The project succeeded in reducing the flood risk in the central urban area of Jingdezhen City through implementation of priority structural and non-structural measures and establishment of an integrated flood risk management system for the City. The flood scheme was completed and successfully handled the 2020 floods. The project also achieved all outcome targets and generated a series of benefits including: guaranteed environmental flows in the Changjiang River, hydropower electricity production, and improving urban water supply as a basic public service. Efficiency was rated High as the project achieved a higher ERR at completion compared to appraisal (20.6% compared to 18%).

With the three outcome criteria (Relevance of Objectives, Efficacy and Efficiency) rated High, outcome is rated Highly Satisfactory.

### a. Outcome Rating

Highly Satisfactory

## 7. Risk to Development Outcome

The ICR (paragraph 91) noted that "the risk to the project's development outcome is low because the sustainability of project outcomes was a key consideration during project design and implementation, and mitigation measures were undertaken for identified risks." The following issues could potentially impact the Risk to development Outcome:

**1. The risk related to the operation and functioning of the Decision Support System (DSS):** This risk was mitigated through equipping the DSS with fully developed O&M plan approved one year before the planned project closing date, which allowed two years in total for model calibration and perfection before project closing. Also, DSS benefited from new professional staff at the Flood Control and Dispatching Center so that they could operate the DSS independently prior to project closing.

**2. The risk related to the potential shortage of O&M funding:** While the project was primarily designed as a flood control project that provides public goods, the reservoir is also used to generate hydro-electricity and provide water supply to downstream communities. The income from hydropower production is able to cover the O&M cost. The multi-purpose design of the reservoir reduces the O&M burden to the government and enhances the financial sustainability of the project.

**3. The environmental and social risks associated with the construction of large dams:** At project completion, there were no pending social or environmental issues or grievances at the closure of the project (ICR, paragraph 91). The resettlement process benefited from consulting and involving communities during the project stages. Also, the project benefited from effective livelihood-restoration programs, and all disrupted



sites were restored, with ecological restoration and water and soil conservation. To conserve fish biodiversity, a fish breeding and releasing station was established and operational in the reservoir. Old trees were transplanted and protected.

**On the heels of the 2020 floods several recommendations were provided by the ICR mission to improve sustainability including:**

- (i) Setting up hydrological stations immediately upstream and downstream of the Wuxikou reservoir to collect data in order to improve the operational rules of the reservoir operation.
- (ii) Continuing to calibrate and improve the hydraulic model using empirical data from the July 2020 floods.
- (iii) Enhancing integrated management of fluvial and pluvial flooding, integrating the 'reservoir and dike' system with the 'urban drainage and pumping' system.
- (iv) Ensuring professional staff stability at the Flood Control and Dispatching Center, which is crucial to maintaining the professional staff skills in terms of operating the DSS.

## **8. Assessment of Bank Performance**

### **a. Quality-at-Entry**

The project objectives were aligned with the Bank and Government priorities with regards to the protection of Jingdezhen City from 50-year flood events associated with the Changjiang River. The project was to support the construction of a flood control scheme which would include a dam and reservoir, a gated overflow spillway with five gates and six bottom outlets, and a hydroelectric power plant to provide more reliable water and electricity supply for the city. The project benefited from a comprehensive design that was built around the Bank's 2010 Policy Note recommendations for Chinese policy makers to develop integrated flood-risk management. However as a result of the dam construction works, the project also achieved renewable energy generation, city water supply provision, watershed management and regulation, which were not part of the objective. These aspects could have been included as part of the PDO and RF.

The project design combined an integrated management approach combining both structural and non-structural measures. Design included a realistic objective with a clear Theory of Change and "appropriate implementation arrangements (ICR, paragraph 63)." Implementation readiness benefited from the approval of project's feasibility study prior to appraisal with international competitive bidding process starting immediately after appraisal, which saved time for implementation (ICR, paragraph 63). This facilitated uninterrupted dam construction except for prolonged rainy seasons in 2016 and 2018. Implementation arrangements were well structured with clear division of responsibilities (ICR, paragraph 63).

According to the ICR (paragraph 64) risk identification and mitigation measures were adequate. Several risks were identified at appraisal including environmental, social, technical, institutional, financial, and procurement risks as well as risks related to dam safety. Design featured adequate mitigation measures, most notable related to dam safety and resettlement: "changing the engineering design of the dam to





Roller-compacted Concrete (RCC) gravity dam in order to enhance its safety and stability, and including resettlement activities as a project component to leverage Bank experience and expertise in mitigating associated social risks (ICR, paragraph 64)." Finally, design benefited from a well-designed M&E system that included a clear and comprehensive Results Framework with realistic targets and adequate indicators in general to monitor the progress, except lack of indicators to better assess the second objective (see section 9 for more details).

Based on the above-mentioned assessment, Quality at Entry is rated Satisfactory. This rating reflects a robust project design that reflected good implementation readiness combined with a well-designed M&E system.

### **Quality-at-Entry Rating**

Satisfactory

### **b. Quality of supervision**

The Bank supervision team carried out supervision missions twice per year. The project avoided potential interruptions caused by TTL transition as the same TTL managed the project from identification to completion. Missions included high-level discussions with senior government officials, technical discussions, and field visits (ICR, paragraph 89). The Bank task team also conducted construction supervision and quality assurance per the Construction Supervision Quality Assurance plan. Supervision provided timely recommendations to solve problems that arose during project implementation. For example, the task team addressed resettlement delays and provided useful recommendations that facilitated the satisfactory completion of the complex resettlement process (ICR, paragraph 89). The project implementation benefited from several training workshops on dam safety management, procurement, financial management, disbursement, and the Bank's safeguards policies as well as hands-on training and guidance that were provided with each project supervision mission.

According to the ICR (paragraph 90) "the task team also brought a lot of managerial experience to the project management entities, such as local governments, the PMO, and the PIUs, which provided them with practical experience for implementing future projects."

Quality of supervision is rated Satisfactory. This rating reflects rigorous and efficient supervision that guided the project implementation towards a successful outcome.

Based on the above-mentioned ratings for both Quality at Entry and Quality of Supervision, Overall Bank Performance is rated Satisfactory.

### **Quality of Supervision Rating**

Satisfactory

### **Overall Bank Performance Rating**

Satisfactory



## 9. M&E Design, Implementation, & Utilization

### a. M&E Design

The project appraisal document (PAD) did not include a Theory of Change (ToC) as it was not mandated at appraisal. Nonetheless, the ICR (page 7) included one which reflected the relation between the planned project activities, its outputs, outcomes and long-term impacts. The ToC included the critical assumptions that underpinned the achievement of the PDOs, which were reasonable. The achievement of the PDO was to be assessed through the following three PDO level indicators: #1. Percentage of urban population protected from 1-in 50-year floods (disaggregated by gender); #2. The flood protection level is increased from 20-year flood to 50-year flood; and #3. Total area subject to inundation by 1-in-50-year floods. These outcome indicators were clear, measurable and directly linked to the PDO indicator #1 (*to reduce the flood risk in the central urban area of Jingdezhen City through implementation of priority structural and non-structural measures*) and were focused on the reduction of flood risks and people affected. The RF did not include specific outcome indicators to assess the second PDO (*to contribute to establishment of an integrated flood risk management system for the City*). The ICR argued that both PDOs reinforce each other so the outcome indicators applied to both, yet the assessment of second PDO could have benefited from separate more specific outcome indicators.

The Results Framework (RF) included twelve intermediate outcome indicators that covered all activities financed by the project. The intermediate outcome indicators were clear and measurable, and served to track the progress of the activities being conducted and completed in order to achieve the outcome indicators. The long-term sustainability of the outcomes was assessed through the indicators on environmental flow and resettlement satisfaction-which were crucial to ensure the environmental and social sustainability of the project and realize the envisaged long-term impacts. The ICR (paragraph 69) noted that the indicator on the "number of people participating in the flood-risk management and answered the flood-risk awareness questionnaire" had an unrealistic target of 0.44 million. According to the ICR (paragraph 69) "this was corrected after clarifying with the PMO and the task team that the indicator was meant to evaluate the number of people participating in flood-risk management activities, instead of those answering the questionnaire."

According to the ICR (paragraph 70) "a baseline M&E report was completed before project negotiations and a third-party independent consultant (the Policy Development Center of the Ministry of Water Resources) was hired to conduct M&E.

Overall, M&E design benefited from a clear and comprehensive Results Framework with realistic targets and adequate indicators to monitor the progress. A minor shortcoming was the lack of independent outcome indicators to assess PDO#2 as mentioned above.

### b. M&E Implementation

According to the ICR (paragraph 70) "the M&E data were collected and verified in a methodologically sound manner by the Project Management Office with the support of consultants." Also, the baseline report was updated semi-annually and submitted to the Bank for review during project implementation. The project data was consolidated by the PMO and reported to the Bank in a comprehensive and timely manner through semiannual project progress reports. The reports tracked progress of civil works, consulting services, and results through the project indicators. Semiannual project



progress reports also reflected progress on institutional strengthening and training. External third party monitoring reports from external agencies provided information on the implementation of the Environmental Management Plan (EMP) and Resettlement Action Plan (RAP). M&E benefited from the Integrated Flood Risk Management Master Plan and the Flood Risk Management that was developed by the Decision Support System (DSS) as this strengthened the M&E processes and informed the development of the O&M plan of the Wuxikou Flood Control Scheme (ICR, paragraph 70).

According to the ICR (paragraph 72) "implementation arrangements for M&E were adequate; data were collected systematically and efficiently, with strong client ownership over the information."

### **c. M&E Utilization**

According to the ICR (paragraph 71) "the M&E data collected were used effectively to inform project implementation and support project management decisions." The Bank task team and the Project Management Office used the project data to monitor progress, identify bottlenecks, and facilitate decision-making or proactive actions, for example, increasing supervision frequency, holding meetings with senior government officials, and making changes to project implementation. The M&E results in 2019 showed that resettlement activities were not completed as planned, this prompted the Bank to grant a one-year extension to ensure satisfactory resettlement results.

Overall M&E Quality is rated High. This rating reflects a comprehensive design that included a robust Results Framework, and adequate implementation of M&E activities as well as effective utilization of M&E data to inform project implementation and support project management decisions.

### **M&E Quality Rating**

High

## **10. Other Issues**

### **a. Safeguards**

The project was classified as a "Category A" operation under Bank OP 4.01. It triggered six Bank safeguards policies: Environmental Assessment (OP 4.01); Natural Habitats (OP/BP 4.04); Pest Management (OP 4.09); Physical Cultural Resources (OP/BP 4.11); Involuntary Resettlement OP/BP 4.12; and Safety of Dams (OP/BP 4.37). The project had several positive social impacts including: increased flood protection level in Jingdezhen City from twenty-year flood up to fifty-year flood; city residents would also benefit from the environmental flow of the Changjiang River during the dry season and hydropower to meet the peak demand. On the other hand, the dam construction and reservoir inundation would result in potentially adverse impacts. A social assessment (SA) was conducted to identify the social risks and impacts of Wuxikou Dam construction. SA results were incorporated into the EIA to guide project design and planning from both the social and environmental perspectives; social management measures were integrated in the Environment and Social Management Plan (ESMP). A Due Diligence Review (DDR) was conducted on the completed resettlement of the five parts of the Di. A Resettlement Policy Framework



(RPF) was developed in compliance with OP4.12 requirements for the remaining Dike construction work and for the potential impact by the transmission line. The RPF would guide Resettlement Action Plan (RAP) preparation for these activities. All social safeguard instruments were disclosed locally on August 30, 2012 and were sent to the InfoShop on September 30, 2012.

The ICR did not explicitly state that the project complied with the Bank's safeguard policies, but stated that "overall Environmental Safeguards performance is rated Satisfactory throughout the project (ICR, paragraph 73)" and "the project's overall Social Safeguards performance is rated Satisfactory (ICR, paragraph 76)."

**Environment Assessment (EA).** Mitigation measures followed several plans including the Environmental and Social Management Plan (ESMP) developed during project preparation, along with the Soil Erosion Control Plan, Reservoir Bottom Cleaning Plan, Physical Cultural Resource Management Plan, and Pest Management Plan. Also, a Second Phase CIA Study Report and a Comprehensive Reservoir Management Plan (CRMP) were completed during project implementation. The studies and environmental monitoring results all confirmed that the project implementation did not have any significant negative impacts on the environment, particularly on the river environment and aquatic habitat (ICR, paragraph 74).

**Natural habitats.** The impacts of the Wuxikou Reservoir did not involve any critical natural habitats and were limited, since the river was fragmented due to cascade development for decades (ICR, paragraph 75). The reservoir included a fish breeding and releasing station that was constructed under the project. A total a population of about 35,600 fish were already released into the river. According to the ICR (paragraph 75), "the first-year aquatic ecology survey (after the reservoir operation) found that the project operation did not bring significant changes to the varieties of fish and the implementation of the fish release program helped to supplement the fish resources in the river."

**Involuntary Resettlement.** By project closure, a total of about 9.6 square km of land was acquired, which physically displaced 10,469 people who were relocated to 29 resettlement sites and housed in brand-new dwellings (ICR, paragraph 76). Also, Chitan city was relocated and rebuilt with all the necessary social services of school, hospital, and market system. In addition, demolished infrastructure facilities like roads and railway were all restored, thus helping to expedite the socio-economic development around the reservoir area. The ICR (paragraph 77) stated that "people relocated were properly compensated and their livelihoods restored in accordance with the requirements of the Bank's OP/BP 4.12" and "over 97.79% of the affected people indicated satisfaction with the resettlement arrangements."

**Safety of Dams.** The Project Management Office (PMO) established a dam safety panel of experts (DSPE) composed of three independent dam safety specialists. The DSPE assisted the PMO and the World Bank team in ensuring compliance with the rules of the Bank's dam safety policy (OP 4.37) during project implementation. Dam safety plans, including the instrumentation plan and the construction supervision plan, were prepared, updated, and reviewed by the DSPE and the Bank. according to the ICR (paragraph 82) "dam construction and safety plans were implemented under the supervision of qualified supervising engineers, the DSPE, and the Municipal Water Affairs Bureau."



## b. Fiduciary Compliance

**Financial Management (FM).** Financial management arrangements were acceptable (ICR, paragraph 85). FM performance benefited from support and on-the-job training by the Bank to relevant financial staff. All seven audit reports were unqualified (clean) opinions and submitted to the Bank on time, only with a slight delay in the first project year. According to the ICR (paragraph 85) "no significant financial management issues were disclosed in the audit reports and the audit findings were gradually addressed by the Borrower."

**Procurement.** Procurement operations were in accordance with the legal covenants and the Bank procurement policy and procedural requirements (ICR, paragraph 86). The Bank task team oversaw procurement and was available to assist and clarify procurement-related issues to the implementing agencies. A total of 33 contracts (9 works, 9 goods, and 15 consulting service contracts) were procured and successfully implemented.

## c. Unintended impacts (Positive or Negative)

None.

## d. Other

Gender.

## 11. Ratings

Ratings	ICR	IEG	Reason for Disagreements/Comment
Outcome	Highly Satisfactory	Highly Satisfactory	
Bank Performance	Satisfactory	Satisfactory	
Quality of M&E	High	High	
Quality of ICR	---	Substantial	

## 12. Lessons

The ICR included five lessons. The following three are emphasized with some adaptation of language:

**1. Successful flood management needs is a risk-based that integrates both structural and non-structural measures.** Flood risks are expected to increase under climate change. Therefore,



flood management needs to adopt a risk-based approach, which requires leveraging risk identification (through the Decision Support System-DSS) to inform the use of risk-reduction measures (i.e., reservoir operation, people evacuation, etc.). The project experience showed that hard infrastructure is most effective when it is supported by non-structural measures including: integrated flood risk management planning, improved flood forecasting and early warning capacity, and community flood awareness and preparedness. The enhanced flood forecasting and early warning capacity facilitated by the DSS can inform the operation of the hard infrastructure (i.e., the reservoir) so that the effectiveness of the hard infrastructure is strengthened.

**2. Flood-protection dams, especially multi-purpose ones can offer substantial socio-economic benefits against natural disasters, especially under climate change, and therefore are worthy investments, but need to be carried out with sufficient risk mitigation measures to address the potential technical, environmental, and social risks.** Under the project, social and environmental risks need to be identified and mitigated with due diligence. Dam safety was a key consideration during project preparation and implementation. In terms of environmental risks, the project has conducted Cumulative Environmental Impact Assessment, which identified that this dam would have limited impact on the environment. Environmental impact mitigation measures were conducted. The project also included one specific component on resettlement and granted a one-year extension to the closing date to ensure that the resettlement work was completed satisfactorily. The recommendations made by the panel of experts were also important to the quality of dam safety management, as well as the environmental and social risk mitigation of the project.

**3. Resettlement efforts are successful when they are adaptive and flexible, and take a participatory and consultative approach.** Reservoir resettlement normally lasts several years, during which time local socio-economic contexts can change substantially. Resettled people's needs will also change with their socio-economic contexts. Thus, in order to mitigate the negative social impacts and enhance the long-term sustainability of project outcomes, resettlement management needs to be adaptive and flexible. Also, the resettled people's changing needs can be well taken into account through a participatory and consultative approach. Resettled people should be fully consulted before and during project implementation and their suggestions and requests need to be fully incorporated into project implementation. In addition, resettlement can be linked to governmental development programs, which not only allows for leveraging government counterpart funding, but also enhances long-term project sustainability.

### 13. Assessment Recommended?

No

### 14. Comments on Quality of ICR

Quality of Evidence. M&E benefited from a robust design, satisfactory implementation and strong utilization. Overall, the M&E system provided important inputs to the ICR and efficiency analysis.





**Quality of Analysis.** The ICR provided clear linking between evidence and findings and used the evidence base to serve the arguments under the different sections, in particular the discussion on outcomes.

**Lessons.** Lessons reflected the project experience and were based on evidence and analysis.

**Results Orientation.** The ICR included a comprehensive discussion on the two objectives. It provided a well balance discussion between reporting on the achievement of outcomes in relation to the indicators and what the project actually achieved on the ground. However, assessing the second objective would have benefited from including specific indicators to assess the achievement.

**Internal Consistency.** Various parts of the ICR were internally consistent and logically linked and integrated.

**Consistency with guidelines.** The ICR successfully used the available data to justify the assigned ratings. Discussion of outcomes was comprehensive, and the efficiency analysis was robust.

**Conciseness.** The ICR was well written and provided comprehensive coverage of the implementation experience and candidly reported on shortcomings. There was enough clarity in the report's messaging. However, the outputs in Annex 1 lacked targets. The ICR also could have noted the lessons reflected in the project design from other Bank-financed projects related to flood management in China.

Overall, the Quality of the ICR is rated Substantial.

**a. Quality of ICR Rating**  
Substantial