



Research Paper

High-quality and sustainable management of water and soil conservation projects

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ABSTRACT

The Chinese people are industrious and great people in the world. In order to meet the needs of population growth for food and a good ecological environment, the Chinese people have worked one after another to control river disasters and water disasters, and established many great water and soil conservation projects, among which the most famous ecological projects are the Dujiangyan project and the Three Gorges dam. After years of operation and practice, it has been proven that the Jiangyan project and the Three Gorges Dam not only irrigate a large area of farmland downstream to meet the needs of people's irrigation, food security and agricultural development, but also meet the needs of ecotourism. It shows that the Dujiangyan project and the Three Gorges dam are high-quality and sustainable management of water and soil conservation projects, but also outstanding ecological projects and public utilities, which will play a more important role in high-quality development of the new era of China.

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Key words: Chinese nation; Dujiangyan project; Three Gorges dam; food security; high-quality sustainable water and soil conservation projects; Ecological engineering.

INTRODUCTION

The Chinese people are an industrious and great nation on the world. In order to meet the needs of population growth from 0.5 billion in 1949 to 1 billion in 2000 and to 1.45 billion in 2020 for food and a good ecological environment, the Chinese people have worked one after another to control river disasters and water disasters, and established many great water and soil conservation projects, among which the most famous ecological projects are the Dujiangyan project and the Three Gorges dam. Dujiangyan and Three Gorges dam is famous ecological engineering for utilities even they are established in different time, China. Dujiangyan is a world cultural heritage listed in the "world cultural heritage" by UNESCO in 2000, a world natural heritage -Sichuan Giant Panda Habitat, a national key cultural relics protection unit, a national scenic spot and a national AAAAA tourist attraction. Dujiangyan scenic spot mainly includes Fulong temple, Erwang temple, Anlan cable bridge, Yulei pass, Lidui Park, Yulei Mountain Park, Yunfeng, Lingyan temple, Puzhao temple, Cuiyue lake, Dujiangyan water conservancy project, etc. The Three

Gorges project has four major benefits, namely flood control, power generation, shipping and tourism.

Dujiangyan project

Minjiang River is an important tributary of the upper reaches of the Yangtze River. During the Warring States period, China (403-221 BC), the Minjiang River in Shu state was flooded every year. People there fought against the flood for generations, but they could not completely solve the problem. People lived in great pain all the time. Later, the state of Qin in the history of China annexed Shu state. In order to build Shu state into its important base, the state of Qin decided to completely control the flood of Minjiang River. Therefore, King Zhaoxiang of Qin state appointed Li Bing, who was very talented in water control, to serve as the Sheriff of Shu State and preside over the management of the flood there. After arriving at Shujun state, Li Bing personally inspected the local disaster situation and found that the

Minjiang River, which originates from Minshan Mountain in the north of Chengdu Plain, has high mountains and deep valleys along both banks of the river, and the water flow is fast. A large amount of sediment brought from the upper reaches of Minjiang River is deposited here, raising the riverbed and aggravating the flood. Especially in the southwest of Guanxian City, there is a Yulei mountain, which hinders the eastward flow of the river. Every summer and autumn flood season often causes drought in the East and waterlogging in the West. After on-site inspection, Li Bing found that the water intake was moved up to Yulei mountain, Guanxian County, at the top of the alluvial fan in Chengdu Plain, which can ensure a large amount of water diversion and form a smooth channel network. His newly planned diversion canal is composed of Yuzui, Feisha weir, baopingkou and channel network.

In the process of building the diversion weir, after Li Bing failed to use the method of throwing stones at the center of the river to build the weir, he opened a new way and let the bamboo workers weave some large bamboo cages, and fill them with pebbles, and then sink into the bottom of the river one by one. In this way, he defeated the turbulent river water and finally built the diversion dike. This method is based on local materials, and the construction and maintenance are simple and easy. Moreover, the accumulation of gabion layers can not only avoid the fracture of embankment, but also use the gap between pebbles to reduce the direct pressure of flood, so as to reduce the risk of embankment collapse. The front end of the diversion dike is like a fish head, so it is called "fish mouth". Yuzui is a diversion weir built in the middle of Minjiang River upstream of baopingkou. It is named because the top of the weir is shaped like a Yuzui. According to the records in the annals of Huayang, Li Bing's "Peng" refers to the fish mouth. It divides the Minjiang River into internal and external rivers and plays the role of shipping, irrigation and flood diversion. In order to further control the amount of water flowing into the mouth of the bottle, Li Bing built a flat flume for flood diversion and a "flying sand weir" spillway at the tail of the Yuzui water diversion dike. The flying sand weir is also built with pebbles packed in bamboo cages, and the weir crest shall be of appropriate height. When the water level of the Neijiang River is too high, the flood will overflow the Feisha weir and flow into the Waijiang river through the flat flume, which can protect the Neijiang irrigation area from flooding.

At the same time, due to the vortex effect of the water flowing over the Feisha weir into the Waijiang River, the sediment before and after the mouth of the Aquarius is effectively washed away. There is a certain proportion of water distribution in the fish mouth. In spring farming season, the inner river accounts for about 60% and the outer river accounts for about 40%. In flood season, the water volume of Neijiang River exceeds that required for irrigation and overflows by Feisha weir. Then, Li Bing led people to dig the mouth of the treasure bottle. Because the

precipice is steep and dangerous, you can't cut through it. Li Bing is burned with accumulated salary", he split Yulei mountain and chiseled it into the mouth of a treasure bottle. Baopingkou not only becomes a water inlet, but also forms an automatic regulating water gate with its narrow channel, which plays a good role in protecting the Neijiang canal system. The rock channel around Baopingkou is very strong. It has not been destroyed by the torrent of Minjiang River for thousands of years, which has effectively controlled the water flow of Minjiang River. Song Shusen, a poet in the Qing Dynasty, wrote the poem "Fu Long Guan Sheng": I heard that the guard of Shu state was chiseling away from the pile, and the two cliffs were broken by Cui Wei. At this point, the Minjiang River draws north and south, and the bottle pours down like thunder. After Li Bing built the mouth of the treasure bottle, he opened two more canals. One canal crossed Xinfan from Yongkang into Chengdu, called Waijiang, and the other canal crossed pi from Yongkang into Chengdu, called Neijiang. The two main canals connect the scattered farmland irrigation canals on the Chengdu Plain, initially forming a large-scale channel network of water conservancy projects.

In the next few years, Li Bing led the people of Sichuan to build many soil and water conservancy projects, such as water diversion Yuzui, King Kong dike and flat flume, at the foot of Yulei mountain in the south of Guan County. These water conservancy projects were later collectively referred to as Dujiangyan (Figure 1). Dujiangyan water conservancy project not only fundamentally controlled the flood, but also turned the disaster into a blessing. It irrigated thousands of hectares of good farmland and benefited the people in Sichuan for generations. Since then, Shu state has been fertile and rich, known as the "land of abundance". Therefore, Li Bing was honored as the "ancestor of Sichuan" by later generations, and was loved and respected by generations of Shu people. Dujiangyan water conservancy project occupies a glorious page not only in the history of water conservancy in China, but also in the history of water conservancy in the world. Its long history is world-famous, and its complete design is amazing. Many water conservancy projects were built in ancient China, but the Dujiang Weir built by Li Bing has been enduring and has been playing a variety of functions such as flood control, irrigation and transportation (Dong et al., 2022).

Three Gorges Dam

Three Gorges dam is a great process known all over the world and has been the efforts of several generations (Figure 2). Earlier In 1919, Dr. Sun Yat Sen put forward the idea of building the Three Gorges Project in the second general plan for the founding of the people's Republic of China - industrial plan. In 1949, the Yangtze River Basin suffered a major flood, and the Jingjiang levee, which was built from the first year of Yonghe to the second year of



Figure 1: Beautiful Dujiangyan project in Sishuan, China



Figure 2: National treasure, three Gorges Dam in Chongqing, China

Xingning in the Eastern Jin Dynasty (345-364 A.D.), was full of dangers. The flood control of the middle and lower reaches of the Yangtze River, especially the Jingjiang River, has attracted attention since the founding of new China. In early 1950, the Yangtze River Water Conservancy Commission of the State Council was officially established in Wuhan. Three years later, the Jingjiang Flood Diversion Project was built. In 1953, Chairman Mao Zedong, while listening to the introduction of the reservoir construction plan for the main stream and main tributaries of the Yangtze River, hoped to build a reservoir in the Three Gorges to "accomplish its work in one battle". He pointed to the Three Gorges on the map and said, "it took so much effort to build a branch water reservoir, but it can't achieve

the purpose of flood control. Why don't you get stuck in this general opening?" "How about repairing the Three Gorges Dam first? In October 1953, the party group of the upstream Bureau of the Yangtze River Water Resources Commission reported to the Finance Committee of the Southwest Bureau that the water storage height of the Three Gorges reservoir may be about 190 meters in the future. The Southwest Bureau is requested to say hello to the cities along the river and relevant units, and do not set up factories or build more important projects below the elevation of 190 meters. The Finance Committee of the Southwest Bureau agreed with this opinion.

In September 1954, Lin Yishan, director of the Yangtze River Water Resources Commission, put forward in the

report on the basic scheme of the river regulation plan that the dam site of the Three Gorges is proposed to be selected in the Huanglingmiao area, and the water level is proposed to be 191.5 m. Since 1955, under the leadership of the CPC Central Committee and the State Council, relevant departments and people from all walks of life have worked together to comprehensively carry out the planning of the Yangtze River Basin and the survey, scientific research, design and demonstration of the Three Gorges Project. In March, a technical assistance contract was signed in Moscow, and the first batch of Soviet experts arrived in Wuhan in June. Four drilling rigs and the seventh topographic survey team affiliated to the Standing Committee have successively entered the Three Gorges area to carry out survey work. In March 1958, Premier Zhou Enlai made a report on the Yangtze River Basin and the Three Gorges Project at the Chengdu meeting of the CPC Central Committee, which adopted the opinions of the CPC Central Committee on the planning of the Three Gorges water control project and the Yangtze River Basin. That month, Premier Zhou Enlai boarded Zhongbao Island in sanduping and studied the optimal scheme of the dam site of the Three Gorges project with accompanying experts. In June 1958, the first scientific research conference of the Three Gorges project was held in Wuhan. After the conference, the report on the scientific and technological research conference of the Three Gorges project was submitted to the central government. In 1970, the central government decided to build the Gezhouba project as a part of the overall Three Gorges project, on the one hand to solve the problem of power supply in Central China, and on the other hand to prepare for the Three Gorges Project. On December 30, 1970, Gezhouba project started. In July 1980, Vice Premier Deng Xiaoping inspected the Three Gorges dam site, Gezhouba construction site and Jingjiang Levee by boat from Chongqing and listened to the report of the Three Gorges Project. Gezhouba Water Control Project is located at the end of the Three Gorges in Yichang City, Hubei Province, China, 2.3 kilometers downstream of Nanjinguan, the outlet of the Three Gorges.

On April 3, 1992, the fifth session of the Seventh National People's Congress decided to include the construction of the Three Gorges Project in the ten-year plan for national economic and social development, and the State Council should choose an appropriate time to organize the implementation according to the actual situation of national economic development and the possibility of national financial and material resources. The Three Gorges project adopts the construction method of "one-time development, one-time completion, phased water storage and continuous resettlement". The reservoir inundation involves 20 districts and counties, more than 270 townships, more than 1500 enterprises and more than 34 million square meters of houses in Hubei Province and Chongqing. From 1993 to 2005, when the resettlement project was implemented, the average number of immigrants per year was nearly 100000,

and a total of more than 1.1 million immigrants bid farewell to their hometown. In January 1993, the Three Gorges Project Construction Committee of the State Council was established, and Premier Li Peng concurrently served as the director of the Construction Committee. The committee consists of three institutions: the office, the Immigration Development Bureau and China Three Gorges Project Development Corporation. On July 26, the second meeting of the Three Gorges Project Construction Committee of the State Council examined and approved the preliminary design report of the Three Gorges water control project on the Yangtze River, marking that the construction of the Three Gorges project has entered the formal construction preparation stage. In August, the State Council issued the regulations on Resettlement for the construction of the Three Gorges project, which stipulates that the State implements the policy of development resettlement in the construction of the Three Gorges project, so as to make the living standards of immigrants reach or exceed the original level, and create conditions for the long-term economic development of the Three Gorges Reservoir area and the improvement of the living standards of immigrants. On September 26, President Jiang Zemin wrote an inscription for the Three Gorges Project: "carry forward the spirit of hard work and entrepreneurship and build the Magnificent Three Gorges Project." On September 27, China Three Gorges Project Development Corporation was officially established. On December 25, the third meeting of the Three Gorges Project Construction Committee of the State Council studied the resettlement of the Three Gorges Project.

On October 16, 1994, when Jiang Zemin, general secretary of the CPC Central Committee and President of the state, inspected the construction site of the Three Gorges project, he pointed out that "since we have made up our mind to start the project, we must unite as one, not afraid of difficulties, work hard and strive for victory". President Jiang Zemin also wrote an inscription for the Three Gorges project: "pay tribute to the builders participating in the Three Gorges project". On November 2, Vice Premier Zhu inspected the Three Gorges project. On November 17, the fourth meeting of the Three Gorges Project Construction Committee of the State Council studied the formal commencement of the Three Gorges project. In December, on his way to the Three Gorges project site by boat to attend the commencement ceremony of the project, Premier Li Peng wrote the "Dajiang song" praising the Three Gorges project. On December 14, Premier Li Peng announced the official commencement of the Three Gorges Project at the commencement ceremony of the Three Gorges project held in sanduping, Yichang. In 1995, the relocation and resettlement of phase I water level immigrants in the Three Gorges Reservoir area was fully started. In August 1996, Xiling Yangtze River Bridge, the largest suspension bridge in China, was officially opened to traffic. In late November, the river closure system project of

the Three Gorges project was launched. In December, Yichang Three Gorges Airport was opened to navigation, which played an important role in better serving the construction of the Three Gorges Project. On December 22, 1996, Vice Premier Wu Bangguo inspected the construction site of the Three Gorges project. In January 1997, the State Planning Commission officially approved the issuance plan of 1 billion yuan of Three Gorges bonds to raise funds for the construction of the Three Gorges Project. In March, the fifth session of the Eighth National People's Congress approved the establishment of Chongqing municipality directly under the central government. This is conducive to the construction of the Three Gorges Project and the unified planning, arrangement and management of resettlement in the reservoir area.

On October 6, 1997, the manually excavated 3.5 km long diversion channel of the Three Gorges project for large fleet navigation was officially opened to navigation. On October 14, the 63rd executive meeting of the State Council passed the acceptance report before river closure of the Three Gorges project, and decided to implement river closure of the Three Gorges Project on November 8. On November 8, 1997, the Three Gorges Project closed the river, marking the successful completion of the first phase of the five-year project and the transformation of the Three Gorges project into the second phase. In early January 1998, China Three Gorges Project Development Corporation formulated the "Three Gorges project quality management measures" (for trial implementation) in accordance with national laws and regulations on project quality and in combination with the actual construction of the Three Gorges project, which was officially implemented in January 1998. From January 13 to 17, 1998, General Secretary Jiang Zemin inspected the resettlement work in Chongqing and the reservoir area, demanding that resettlement be put first, seize the opportunity and work hard. On April 21, 1998, the first phase excavation project of the Three Gorges permanent ship lock passed the completion acceptance. The qualified rate of the project quality reached 100% and the excellent rate reached 82.6%. The overall quality fully met the design requirements. On May 1, after five years of construction, the temporary ship lock of the Three Gorges of the Yangtze River was officially opened to navigation. This is the largest double track five level ship lock in the world. On May 14, the elastic wave detection project on the foundation surface of the first phase main project of the Three Gorges water control project submitted by the geophysical survey and Research Institute of the Yangtze River Water Resources Commission passed the expert review and acceptance, and its result report was officially filed and recorded in the history of the Three Gorges Project.

On June 1, the anti-seepage wall downstream of the phase II cofferdam of the Three Gorges project was declared closed, with a total area of 25746 square meters. The water volume of the dam site of the Three Gorges project has reached the normal value of 57700 cubic meters since the

construction of the Three Gorges Project in July, and the dam site has withstood the flood of 1877. On October 8, the berthing pier of the upstream approach channel of the Three Gorges permanent ship lock was poured with the first party concrete, which marked that the world's largest ship lock has changed from the excavation stage to the concrete pouring stage. From December 28 to 30, Zhu Rongji, premier of the State Council and director of the Three Gorges Construction Commission of the State Council, inspected the reservoir and dam area of the Three Gorges project, and earnestly warned all the builders of the Three Gorges project that the Three Gorges project is a grand plan for the millennium, which is related to the National Movement, the quality is the life of the Three Gorges project, and the quality responsibility is heavier than Mount Tai. On March 12, 1999, the largest plate bending machine in China manufactured by Shanxi Changzhi forging machine tool factory was officially put into use at the construction site of the Three Gorges. The smooth operation of the machine indicates that China has become one of the few countries in the world that can produce super large plate bending machines. On October 3, 1999, the last rock ballast of the protective layer of the fifth lock head on the south line of the permanent ship lock of the Three Gorges project was transported to the ballast yard. So far, the excavation of the south line of the permanent ship lock undertaken by the fourth detachment of the hydropower force of the armed police has been successful, which marks the successful completion of the excavation project of the main body of the permanent ship lock. On December 31, 1999, the Three Gorges project completed 4.5852 million cubic meters of concrete pouring throughout the year, exceeding the plan of 4.48 million cubic meters of concrete pouring per year, far exceeding the record of 3.2 million cubic meters of concrete pouring per year.

On January 24, 2000, the foundation ring of the first unit of the power house on the left bank of the Three Gorges project was installed in place at unit 1, marking the transformation of the power house construction on the left bank of the Three Gorges Project from civil construction to civil construction and unit embedded parts installation. On March 17, 2002, the runner of the first generator set of the Three Gorges project was successfully hoisted. On May 1, the Three Gorges project successfully implemented the blasting of the upstream cofferdam. In 1997, the upstream cofferdam formed by the closure of the river completed its historical mission. On September 1, the water commissioning of the permanent ship lock of the Three Gorges Project began. The permanent ship lock is designed according to the requirements of 50 million tons per year and 10000-ton fleet. The ships passing through the permanent lock include a 10000-ton fleet, and it takes about 2 h and 35 min to pass the lock each time. According to the construction plan of the Three Gorges project, the ship lock will be open to navigation in June 2003. On September 1, the 120000 second phase relocation and

resettlement task of the Three Gorges Reservoir area issued by the State Council was fully completed, and the reservoir cleaning work under the water level of 135 meters was nearing the end. On October 21, the most critical flood discharge dam section of the Three Gorges dam was completed, reaching the design elevation of the dam at an altitude of 185 meters. On October 25, the State Council held a plenary meeting of the Acceptance Committee of the second phase of the Three Gorges Project and agreed with the opinions of the acceptance team of the pivotal project on the implementation of diversion open channel closure in November 2002. On October 26, the 1.6 km long Three Gorges phase II dam was capped, and the whole section of the dam has been raised to the design crest elevation of 185 m above sea level. On October 29, Premier Zhu Rongji presided over the 11th meeting of the Three Gorges Project Construction Committee of the State Council, agreed with the opinions of the Three Gorges phase II Project Acceptance Committee of the State Council, and decided to carry out the closure and closure of the diversion open channel on November 6. The next day, the Three Gorges Project Development Corporation announced the decision of the third construction commission of the State Council.

On November 6, 2002, the diversion channel of the Three Gorges project was closed. The open diversion channel with a total length of 3.7 kilometers and a channel width of 350 meters is a section of "artificial Yangtze River" excavated to solve the navigation and overflow during the second phase of the Three Gorges Project. On November 7, the rotor of the world's largest water turbine generator set was successfully hoisted at the construction site of the Three Gorges, marking the basic completion of the installation of large parts of the first unit of the Three Gorges and entering the general assembly stage from then on. On December 16, the third phase RCC Cofferdam of the Three Gorges Project began pouring. The total design pouring volume of phase III cofferdam is 1.1 million cubic meters. It will protect the right bank dam, power plant and no overflow dam section construction on the right bank together with the downstream earth rock cofferdam. It is a key project to realize water storage, navigation and power generation of phase III project. On February 27, 2003, the third and fourth phases of resettlement in the Three Gorges Reservoir area were fully launched. On April 11, the temporary ship lock of the Three Gorges project was closed to navigation, and the navigation in the Three Gorges area of the Yangtze River was suspended for 67 days, and the navigation was resumed on June 16. At the same time, the dam turnover and transfer work were fully started. On April 16, the Three Gorges phase III RCC cofferdam reached the top of the whole line, reaching the design elevation of 140 m 55 days ahead of the contract period. On April 22, the reconstruction of the temporary ship lock on the left bank of the Three Gorges Project and the flushing lock project started. On April 27, the second phase resettlement project of the Three Gorges project passed the national acceptance.

This marks a major phased achievement in the resettlement work of the Three Gorges Reservoir area. The resettlement and construction under the 135-meter water level in the Three Gorges Reservoir area and the cleaning of the reservoir bottom have been fully completed, meeting the requirements of the scheduled water storage of the Three Gorges Project. On May 21, the hub project acceptance team of the acceptance committee of the second phase of the Three Gorges project of the State Council officially announced that the second phase of the Three Gorges project has reached the water level of 135 meters and the requirements of ship trial navigation. It is agreed that the lock of the Three Gorges project will be closed for water storage on June 1, and the trial navigation of the permanent ship lock can be implemented in June 2003. So far, China has built the ship lock with the largest water level drop in the world.

On May 30, the Three Gorges Project successively opened four flood discharge deep holes 20, 21, 22 and 23 located in the flood discharge dam section, which was the first time since the completion of the flood discharge hole of the Three Gorges Project. At 0:00 on June 1, the gate in the Three Gorges dam was started on time as planned, and the Three Gorges project was officially closed for water storage. The total length of the ship lock of the Three Gorges project is 6.4 km, including 1.5 km of the main part of the ship lock 6 km, approach channel 4.8 km. The Three Gorges ship lock is a double track 5-step ship lock, with the largest project scale in the world. On June 7, 2013, the National Audit Office announced the audit results of the draft financial final accounts of the Three Gorges project. The audit results show that the total amount of financial final accounts of the Three Gorges project is 207.873 billion yuan. At present, the Three Gorges hydropower station is the largest hydropower station and clean energy base in the world, and it is also the largest construction project in China's history. There are more than ten functions of the Three Gorges hydropower station, such as shipping, power generation, planting and so on. The Three Gorges Hydropower Station was approved by the National People's Congress of China in 1992 and officially started construction in 1994. It began to store water and generate electricity in the afternoon of June 1, 2003 and was fully completed in 2009. The unit equipment is mainly provided by VGS joint venture composed of German Voith company, American General Electric Company and German Siemens company, and ALSTOM joint venture composed of French Alstom company and Swiss ABB company. The dam elevation of the Three Gorges hydropower station is 185 meters, the water storage elevation is 175 meters, and the reservoir is 2335 meters long. Since 2003, there has been a serious shortage of power supply in China. Coal prices have soared. The Three Gorges unit began to generate electricity at the right time. In the first two years of its operation, the power generation capacity exceeded the scheduled plan and the supply exceeded the demand. It was put into operation on July 4,

2012, which means that the Three Gorges Hydropower Station with an installed capacity of 22.4 million KW has become the largest hydropower station and clean energy production base in the world on July 4, 2012.

CONCLUSION

The Three Gorges of the Yangtze River and Dujiangyan project in China is not only a great ecological engineering but also the Livelihood project since established because there is not an occurrence of danger; and they are the good examples of high-quality sustainable development of soil and water conservation (Guo 2020). The Three Gorges of the Yangtze River and Dujiangyan project is a famous scenic spot in China. Every year, thousands of thousands of people from over the world visit the Three Gorges of the Yangtze River and Dujiangyan project. The Three Gorges of the Yangtze River and Dujiangyan project is not only a great ecological engineering but also earn billions of moneys through water power electricity, water transportation and tourist but also reduce or even eliminate flood disasters.

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