Engineering Geology for a Habitable Earth

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Field Trip #3

THE XIV CONGRESS OF THE INTERNATIONAL ASSOCIATION FOR ENGINEERING GEOLOGY AND THE ENVIRONMENT

第14届国际工程地质与环境大会

Chengdu, China | Sept. 21-27, 2023

Sponsor

- International Association for Engineering Geology and the Environment (IAEG)

Organizers

- IAEG China National Group
- Engineering Geology Commission, China Geology Society
- State Key Laboratory of Geohazard Prevention and Geoenvironment Protection, Chengdu University of Technology

XIV IAEG Congress 2023 Field Trip

Field Trip #3：Chengdu---Badong---Three Gorges Dam---Chengdu

26-27 September 2023 – 2 FULL DAYS WITH ACCOMMODATION
Departure on 26/9 – return to Chengdu on 27/9.
Meeting point: Century City International Convention Centre (1F)
Date and Time: Sept. 26, 06:40 am.

Organizers:
Prof. Changdong Li, China University of Geosciences (Wuhan)
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Topic: The Three Gorges hydropower project and reservoir landslide disasters

General Description:

The Three Gorges Hydropower Station is the world's largest hydropower station and the largest construction project in China. The accompanied issues, such as immigration, relocation, and environmental issues, have attracted widespread attention from the moment of its establishment. After the impoundment of the hydroelectric reservoir, the hydrological environment of the original bank slope has been greatly changed, leading to the revival of many large landslides. This scenic route focuses on the Three Gorges hydropower project and reservoir landslide disasters, passing through Badong County and Yichang City in Hubei Province. The activity will last for two days. The two key scenic spots in this route are: (1) Badong Large-scale Field Integrated Experimental Site: established in the Huangtupo landslide with the largest volume in the Three Gorges Reservoir Area. A three-dimensional comprehensive observation is carried out for this landslide. It allows for close observation of the geological structure and deformation characteristics of the landslide. (2) Three Gorges Dam: You can come to the vicinity of the top of the Three Gorges Dam to view the whole scenic area. Understand the construction process and functions of the Three Gorges Dam by visiting different scenic spots.

Fig. 1 The map of the field trip itineraries

DATE	TIME	ROUTING
Sept. 26	06:00-07:00	Breakfast
	07:00-07:30	Departure to Chengdu East Railway Station by Bus
	07:30-08:00	Chengdu East Railway Station Check in
	08:42-13:00	Departure to Badong by Bullet Train(G3423)
	13:20-14:00	Arrive at the Hotel and Check in
	14:00-14:10	Departure to the Shennong Stream by Bus
	14:10-16:30	Visit the Shennong Stream by Boat
	16:30-16:50	Departure to Badong Large-Scale Field Integrated Experimental Site by Bus
	17:00-18:30	Visit Badong Large-Scale Field Integrated Experimental Site
	18:30-19:30	Dinner
	19:30-19:50	Return to the Hotel for Rest
Sept. 27	06:30-07:30	Breakfast
	07:30-10:30	Departure to Three Gorges Dam
	10:40-12:00	Visit three Gorges Dam
	12:00-13:00	Lunch
	13:00-14:10	Departure to Yichangdong Railway Station by Bus
	15:06-22:00	Departure to Chengdu by Bullet Train (D2223)
	22:20-23:00	Return to the Hotel in Chengdu By Bus

1. Shennong Stream

The Shennong Stream basin is located on the left bank of the Yangtze River. It originates from the southern foot of the famous "First Peak in Central China" in Shennongjia, with a total length of 60 km and a relative drop of over 2,900 m. The average annual flow is 20 m^3/s, which flows into the Yangtze River 2km east of Wuxiakou. The river is flanked by steep cliffs, with narrow sections measuring less than 5 m. The mountain rocks form vertical cliffs with angles of 80 to 90 degrees, creating three distinctive natural gorges: Shen Nong Gorge, Ying Wu Gorge, and Long Chang Gorge. The Shennong Stream is located at the junction of the Daba Mountains and Wushan Mountains, belonging to the low mountain valley area of the Sichuan-Hubei fold belt, composed of carbonate and clastic rocks. Both sides of the river have steep slopes, and the micro-landforms mainly consist of steep cliffs and slopes. The rock types mainly include purple-red mudstone of the Permian Badong Formation, as well as limestone of the Permian Jialingjiang Formation and Daye Formation. The cliffs on both sides of the gorge are dotted with caves, and enormous stalactites hang suspended in the air, representing typical karst landforms. On the 150-meter-high cliffs, groups of rock coffins can be seen.

Fig. 2 Karst Landforms of Shennong Stream **Fig. 3 Shennong Stream Gorge Landforms**

The unique geographical environment and natural conditions provide the conditions for the emergence of the trackers. Due to the shallow water of Shennong Stream, it is like a land boating. On the beach, the trackers need to pull the fiber together. When going down the beach along the water, if the small water passes the shoal, the trackers will also compete to push the boat across the beach. In the case of medium water, the trackers should pull the fiber backward to limit the speed of the boat to prevent hitting the reef.

2. Badong Large-scale Field Integrated Experimental Site

The Badong Large-scale Field Integrated Experimental Site is located in the loess slope area. It is a key project for the construction of the Hubei Badong Geological Hazard National Field Scientific Observation Research Station and the Ministry of Education's "Innovation Platform for Geological Hazard Research in the Three Gorges Reservoir Area" (985 Advantageous Discipline). It is a comprehensive field teaching and research base of landslide geological hazards that integrates teaching, research, and popularization at China University of

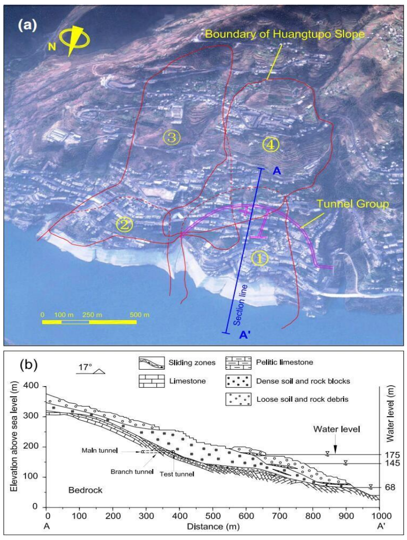
Geosciences (Wuhan).

Fig. 4 Badong Large-scale Field Integrated Experimental Site

History

The Huangtupo landslide is located in Badong County in the Three Gorges area. The original downtown of Badong is below the 175 m water level; hence, Badong was relocated to the Huangtupo area in 1982 for the subsequent impoundment of the Gezhouba and Three Gorges Reservoir. In 1992, however, landslide risk assessments and monitoring indicated that a large and deep landslide existed in the Huangtupo area. In consideration of the safety of the lives and property of more than 18,000 residents, in 1992, the downtown area of New Badong began relocating to an area approximately 10 km west of Huangtupo. Since then, the Huangtupo area has been identified as a massive reactivated ancient landslide, which was confirmed when two regional landslides occurred near the toe area in 1995. The Huangtupo landslide is considered one of the largest and most destructive landslides in the Three Gorges area.

According to the investigation, the main geological structure of the study area is the Guandukou syncline, which has an east-west-oriented axis. Because the axis of the syncline is parallel to the Yangtze River, the bedrock in both banks generally dips towards the valley. Additionally, multiple weak interlayers are present in the strata of the Badong Formation. This combination of lithology and structure has induced many landslides that are sliding towards the reservoir. The bedrock in the study area is composed of clastic and carbonate rocks with continental and transitional facies in the Middle Triassic Badong Formation (T_2b). The Huangtupo landslide has formed in the limestone and marlstone of the third member of the Badong Formation (T_2b^3). The landslide material is primarily loose rock and soil debris, and fragmented rock mass originating from the T_2b^3 marlstone. Boreholes and tunnels have exposed several weak pelitic interlayers in the bedrock of the Huangtupo landslide. Smooth shearing surfaces appear clearly in the bedding plane. The Huangtupo landslide is a group of landslides comprising the No.1 riverside sliding mass, the No.2 riverside sliding mass, the Garden Spot landslide, and the Transformer Station landslide, along with small nearby landslides. The total area and volume of this landslide group are 1.35×10^6 and 6.93×10^7 m^3, respectively.



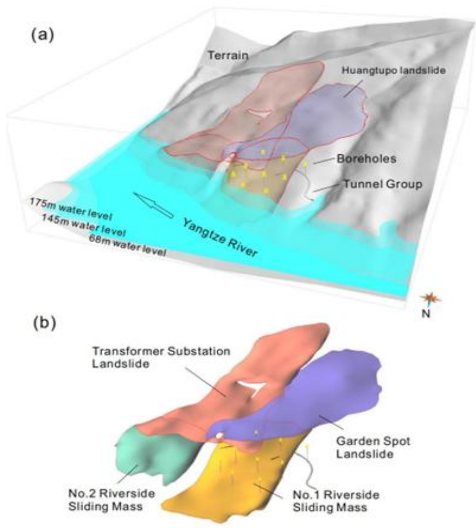


Fig.5 Typical cross section **Fig.6 3D model of the Huangtupo landslide**

To study the behaviors of the landslides during the reservoir operation, a field test station, known as the Badong Large-scale Field Integrated Experimental Site (BLFIES), was built at Huangtupo from 2009 to 2012 by the China University of Geosciences (Wuhan). It is the most extensive underground landslide monitoring and testing facility in the world, built to foster research, teaching, and academic exchange on geohazards.

Monitoring systems

The BLFIES facilities consist mainly of a tunnel complex in the No.1 Linjiang landslide and a series of monitoring and measuring systems. The tunnel complex consists of one main tunnel (with a length of 908 m and a width of 5 m), five branch tunnels (5 m to 145 m long and 3.5 m wide), two experimental platforms, and 35 observation windows (1.0 m wide and 1.5 m high). The tunnel complex allows observations of bedrock, sliding mass, and sliding zone. The facilities at BLFIES can be used to determine the mechanical and hydraulic properties of soil and bedrock in place. The monitoring systems can monitor the surface and underground deformations and measure the hydrologic, meteorological, and hydro-chemical parameters.

- Experimental platform

BLFIES contains the in situ triaxial CREEP test system and in situ direct shear apparatus, and the test samples is prepared in-situ in the sliding zone (located at the end of No.3 branch tunnel). These tests provide a reliable basis for the stability analysis of loess slope landslides.

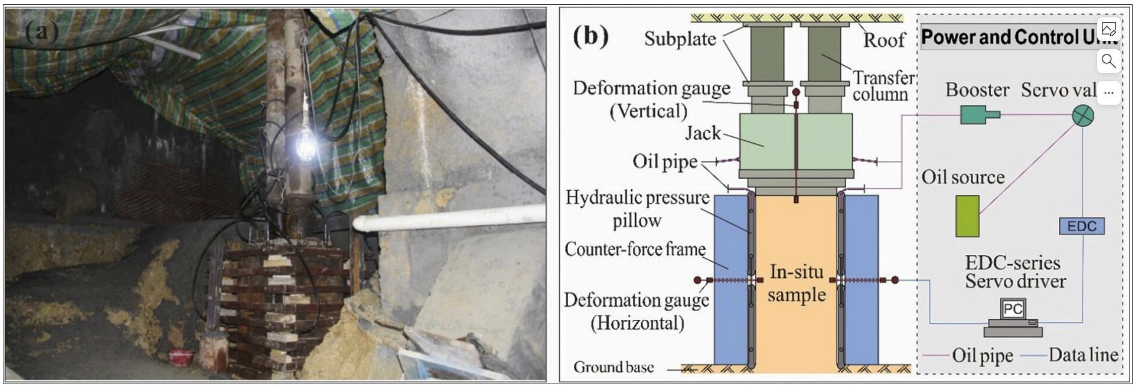


Fig. 7 In-situ triaxial creep test in the sliding zone at BLFIES

Fig. 8 In-situ direct shear test in the sliding zone at BLFIES

- Rainfall and water level monitoring

The flood period of the Yangtze Badong section lasts from July to September. The historic highest water level is 112.85 m (measured in 1970). The drought period lasts from January to March. The historic lowest water level is 54.77 m (measured in 1979). After the impoundment of the Three Gorges Reservoir, the water level increased to 135 m in June, 2003, and 156 m in June, 2006. At the end of the flood season in 2008, experimental impounding further increased the water level in the reservoir. The highest water level reached 172.8 m by the end of 2008 and 171.4 m by the end of 2009. In October 2010, the reservoir water level reached its highest designed value of 175 m for the first time. Since then, the Three Gorges Reservoir operated with a water level of 145~175 m.

- Earth surface deformation monitoring

In 2003, nine GPS earth surface deformation monitoring points were installed on the Huangtupo No.1 riverside sliding mass. G1, G2, G3, and G20 are located on the front edge of the slope, G7 and G22 are located on the middle front area, G9 and G18 are located on the middle rear area, while G11 is located on the rear area of the sliding mass.

- Deep deformation monitoring

From 2003 to 2010, three monitoring boreholes equipped with inclinometers worked on the Huangtupo No.1 riverside sliding mass with names BDZK5, HZK5, and HZ6. BDZK5 is located on the front edge, while HZK5 and HZ6 are located in the middle area of the sliding mass. During the monitoring period of BDZK5, between September 2004 and January 2007, an obvious shear slip surface was observed between depths of 63.5 and 64.5 m. The cumulative displacement during this time was about 54.3 mm. Borehole HZ6 worked from March 2003 till September 2010. The sliding zone observed by it is located between 44.0 and 46.0 m depths, and during this time had a cumulative displacement of 78.9 mm. The sliding zone monitored by HZK5 from May 2006 to June 2009 is located between 76 and 77m depths and had a cumulative displacement of 32.2 mm during this time.

An investigation conducted in September 2013 discovered 24 cracks in different areas of the internal surface of the tunnels. Seven crack meters were installed on the sites of cracks C006, C010, C012, C301, C302, C303, and C501. Collected crack development data.

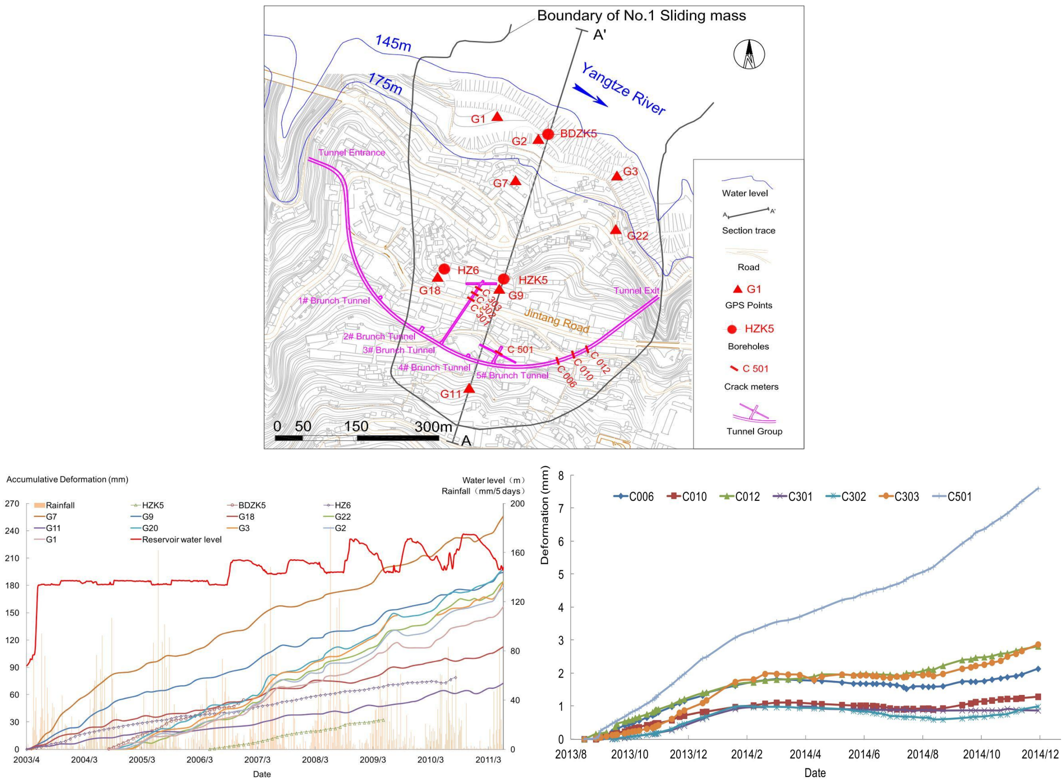


Fig. 9 Monitoring point distribution and monitoring data

Significance

The construction of this large-scale landslide Experimental site pioneered the use of excavating large-scale tunnel groups for scientific observation and research of geological hazards. It was listed as one of the top ten advancements in the field of engineering geology at the 2018 National Engineering Geology Conference. Through the tunnel system of the Experimental site, researchers can directly access the I landslide body of the loess slope, observe the slip surface, sliding zone, and sliding mass at close range, and conduct related large-scale in-situ Experimental and deep observation work.

The Experimental site consists of an underground tunnel group and a series of observation and experimental systems. The main tunnel is 908 meters long and 5 meters wide, with 5 branch tunnels, 2 experimental platforms, and multiple observation windows. Among them, Branch Tunnel No.3 is 145 meters long, Branch Tunnel No.5 is 40 meters long, and Branch Tunnel No.2 is 10 meters long, while Branch Tunnels No.1 and No.4 are reserved. The Experimental site is equipped with a comprehensive monitoring system for real-time multi-physical fields in the sky, ground, and deep areas. Through continuous observation and scientific experiments using multiple methods, the deformation, failure, and environmental changes of the landslide body can be monitored in real-time, providing reliable observation, experimental data, and decision-making basis for landslide hazard assessment and disaster warning. It also provides strong support for the research on the evolution mechanism and prevention of submerged landslides in the reservoir area.

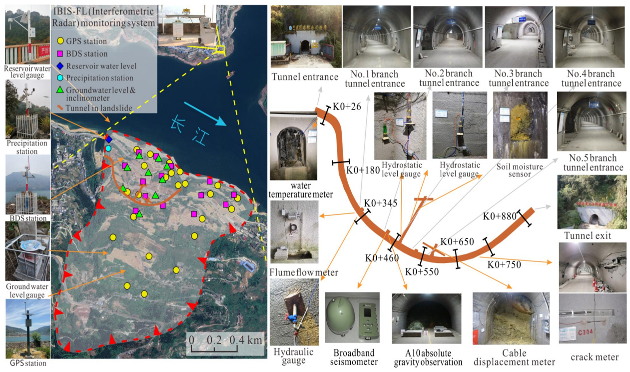


Fig. 10 Badong Large-scale Field Integrated Experimental Site

3. Three Gorges Dam

The Three Gorges Dam is located in the San Dou Ping Town, Yiling District, Yichang City, Hubei Province, within the Three Gorges Dam Tourism Area. It is situated in the Xiling Gorge section of the Yangtze River, at the eastern end of the Three Gorges Reservoir. With a controlled drainage area of approximately 1 million square kilometers, it was first constructed in 1994. The dam integrates flood control, power generation, navigation, and water resource utilization. It is the main project of the Three Gorges Hydroelectric Power Station, the core landscape of the Three Gorges Dam Tourism Area, and one of the largest hydraulic engineering structures in the world today.

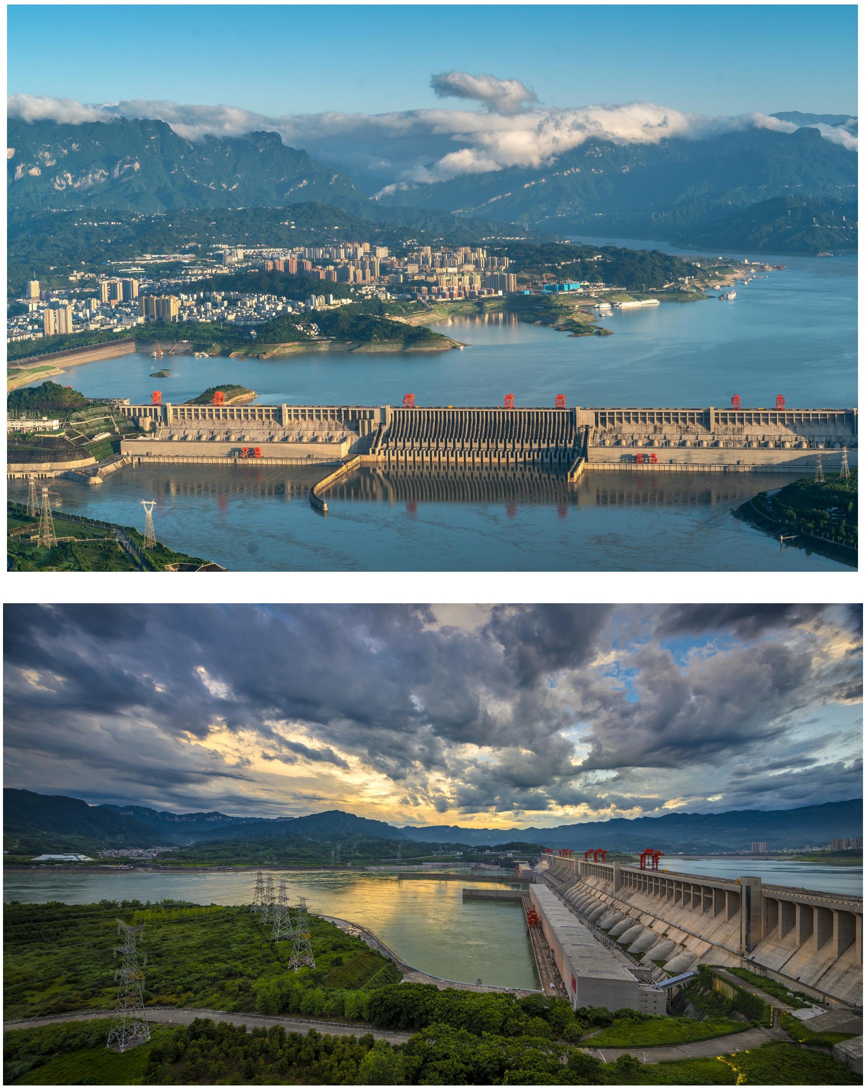


Fig. 11 Panoramic view of the Three Gorges Dam

Fig. 12 Three Gorges Dam Ship Locks

Background

The Three Gorges Project plays an important strategic role in developing and managing the Yangtze River.

The biggest social benefit of the project is flood control. After the completion of the project, the flood control standard of Jingjiang can be raised from the present one in ten years to one in a hundred years, effectively reducing the threat of flood to the middle and lower reaches of the Yangtze River, and bringing peace to the people of one side. The Three Gorges Hydropower Station has a total installed capacity of 32 units of 700,000 kW, with a total installed capacity of 22.4 million kW. If it is fully operational, it will reach 100 billion kW·h per year, ranking first in the world. The Three Gorges Project can fundamentally improve the 660-kilometer Chuanjiang waterway between Chongqing and Yichang, and the 10,000-ton ship can go directly to Chongqing, reducing shipping costs by 37%; The construction of the Three Gorges Project has greatly promoted the development of the Three Gorges tourism industry, and the Three Gorges Dam tourist area has quickly become the leader of the Three Gorges tourism industry. At the same time, the Three Gorges project also exerts its huge comprehensive benefits in water supply irrigation, development of aquaculture, protection and maintenance of ecological balance, purification of the environment, development migration, south-north water diversion project and so on.

Fig. 13 General view of the Three Gorges Dam

The Yangtze River is a rain-flood river. Due to the influence of the southwest monsoon climate and the rotation of the earth, the annual rainfall in the Yangtze River basin is concentrated and there is more rain, and the rainy season enters from June to July every year. In history, floods once caused disasters, the people suffered from them, and the Yangtze River flood has become the heart of the Chinese nation. From the Han Dynasty to the end of the Qing Dynasty, more than 200 floods occurred in the middle and lower reaches of the Yangtze River, with an average of about once every 10 years. The flood of 1870 (the ninth year of Tongzhi of Qing Dynasty) was a great flood in the upper and middle reaches of the Yangtze River. It was a "rare disaster in hundreds of years" because of its great disaster, great loss and extensive damage. The maximum peak flood flow in Yichang reached 105,000 m^3/s, and the total flood volume in 30 days was 165 billion m^3, several cities were devastated, and the two lakes and plains were a vast ocean, and tens of thousands of people were killed by the flood. In modern times, from 1911 to 1949, there were seven major floods, which raged and caused heavy losses. In the summer of 1931, heavy rain in the Yangtze River basin affected 205 counties in 7 provinces in the middle and lower reaches of the Yangtze River and flooded 50.9 million mu of farmland. Fifty thousand people lost their lives in the flood. In 1935, a heavy rainstorm occurred in the Yangtze River, inundating 22.46 million mu of farmland and affecting more than 10 million people. 20,000 people lost their lives. The 1954 flood was the largest flood in the 20th century. Despite a series of flood control measures and three times the newly built Jingjiang River flood diversion project, the damage was still huge. More than 3 million hectares of farmland were inundated, 18.88 million people were affected and more than 30,000 people were killed. The Beijing-Guangzhou railway was suspended for 100 days, causing huge losses to the national economy.

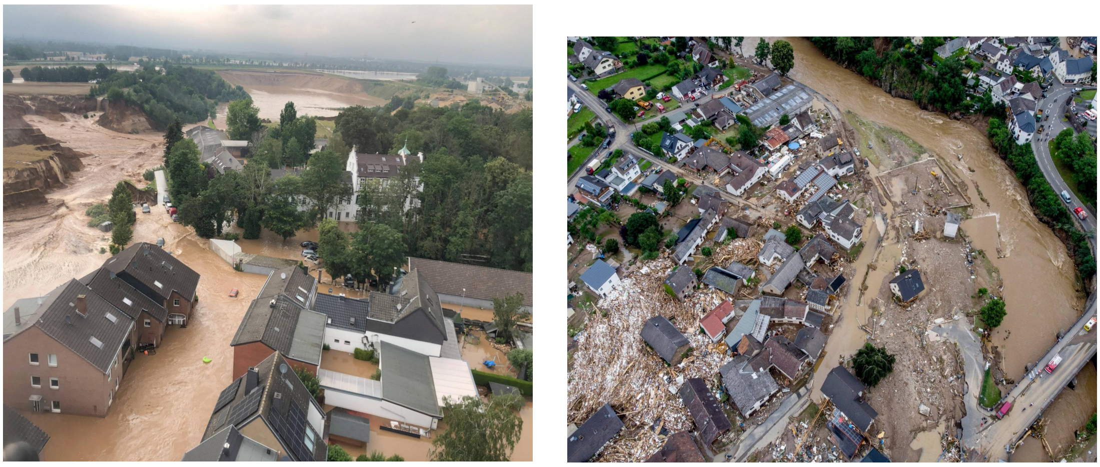


Fig. 14 Houses and fields were flooded and destroyed

Throughout the ages, the Chinese nation has never stopped in its quest to govern and develop the Yangtze River. In ancient times, there was a beautiful legend of the Wushan goddess assisting Yu to control the river and the Xiling Gorge God Ox helping Yu to open the river. The completion of the Three Gorges Project will further protect more than 1.53 million hectares of farmland and more than 15 million people in the Jianghan Plain and Dongting Lake areas. The standard of flood control in the middle reaches of the Jingjiang River has been raised from once in a decade to once in a hundred years, and a flood control system has been initially formed in the middle and lower reaches of the Yangtze River. Even in the event of a "once in a thousand years" flood, the Three Gorges Project can also cooperate with the downstream Jingjiang River flood storage project to avoid devastating floods in the Jingjiang area. The Three Gorges Project is an ecological project for flood control and disaster reduction, a water conservancy project for energy conservation, emission reduction and promoting the development of low-carbon economy, and a great undertaking of "developing in protection and protecting in development".

History

For the Three Gorges Project, the total duration of 17 years is divided into three phases.

Tab. 1 Three Steps

Step	Year	Construction procedure	Water level (m)
The first step (1992-1997)	1992	preparatory phase	66
	1994	begin construction	66
	1995	construction of longitudinal concrete cofferdam	66
	1996	construction of widthwise concrete cofferdam	66
	1997	successful chopping current start-up of diversion canal	66
The second step (1997-2003)	1998	opening of temporary ship lock	66
	1999	excavation of double channel ship lock	66
	2000	resettled people 295,000	66
	2001	resettled people 325,000	66
	2002	closure of diversion canal completion of the left bank concreting	66
The third step (2003-2009)	2003	water level 135 m	135 (139)
	2004	opening of double channel ship lock connection between 10 turbines and the grid	139
	2005	completion of the left bank power generation chamber	139
	2006	completion of the right bank concreting resettled people 1.2 million	156
	2007	water level 156 m	156
	2008	water level 175 m operation of 26 turbines	175
	2009	Project completion opening of ship lock	175

The first part lasted for five years (1992-1997), including preparation of construction work, a cofferdam filling, excavation and construction of the diversion channel, so that the ship was still going through the river's main channel. Constructing of the temporary ship lock and the left bank of the permanent ship lock was done at the same time. After the completion of the diversion channel navigation and the left bank of the temporary ship lock, the earth-rock cofferdam was removed. On November 8th, 1997, damming the river was realized. At this point, the first part of the Three Gorges Project was successfully completed.

The second part work lasted for six years (1997-2003), which includes horizontal filling of earth-rock cofferdam along the water course, draining the water in the Yangtze River Foundation, as well as the constructing the spillway, the left bank of plant monolith and the powerhouse. In November 2002, the diversion channel succeeded in closuring (secondary closure project), ships change route to the temporary ship lock. After June 1st, 2003, the Three Gorges Reservoir began to store water, on June 10th water storage was 135 m, and "high gorge with flat lakes" landscape had become a reality within 10 days. June 16th, the permanent ship lock began working and on July 10th, the first No.2 unit with capacity of 70 thousand kW began generating. The year 2003 was a very meaningful year for the Three Gorges Project. Till then the Three Gorges Project had finished water storing, navigation and power generation, and start to getting benefit.

The third part of the work lasted for six years (2003-2009), including completing the right bank of plant dam, powerhouse and the right bank of the spillway crest, finishing the pouring of concrete to 185 m high, installing the corresponding metal structure and completing the installation of 26 generating units of the left and right banks, and finishing all power transmission projects. On May 20th 2006, people accomplished the last part of concrete pouring; the Three Gorges Dam across the board reached the designed elevation of 185 m, marking the Three Gorges Dam's basically completion. On October 27th the same year, the dam water rose up to 156 m, the Three Gorges Project began to play its full comprehensive benefits. In October 2008, the last units of the dam on the right bank were to the grid, so far, 26 generating units on left and right banks were all put into operation. On June 30th, 2009, all the 26 units were put into use for the first time, the generating capacity exceeded 400 million kW·h. On August 30th, 2009, the normal water level achieved 175 m.

Building

The Three Gorges Dam includes three major buildings.

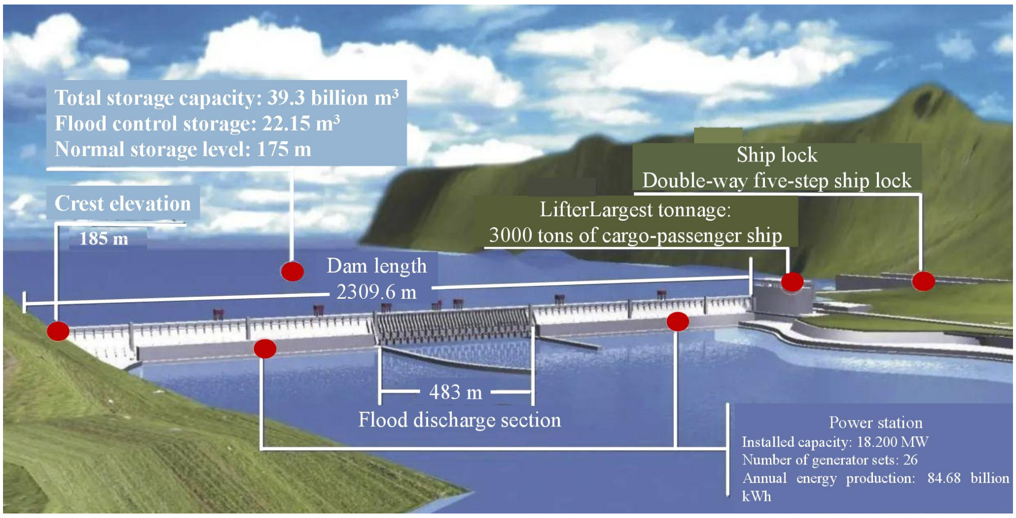


Fig. 15 Three Gorges Water Control Project schematic diagram

One is flood retaining and discharge structure. The dam is a concrete gravity structure with a pouring capacity of 28 million m^3. The hierarchical layout with 99 water channel holes for various purposes including the dam spillway, flushing, draining and generating. There also are corridors of a variety of uses, tens of thousands of km of wire and cable, as well as tens of thousands of instrumentations that makes the dam like a huge underground palace. Three Gorges Dam's total axis length is 2,309.6 m, the Maoping dam's total axis length is 1840 m, the crest elevation is 185 m, the maximum height is 181 m, and the width on top is 15 m with the bottom width of 124 m. The flood discharge section is located in the middle of the riverbed. The total length of the sluice gate is 483 m with 22 spillway surface holes and 23 deep holes, and the designed maximum flood discharge capacity is up to 102, 500 m^3/s .

The other major structure of the Three Gorges Dam is the hydroelectric building. The power station plant is located behind the dam, that is to say the power station built at the back of the dam. The spillway installed 32 generating units, with 14 units on the left and 12 on the right bank, and 6 units was installed underground on the right bank. Generating capacity for each unit is 700,000 kW; the total installed capacity in Three Gorges Power Station is up to 22.4 million kW.

The third major part of the project is the permanent navigation structures, consists of double-cable ship lock and ship-lift built on the left bank. The double-cable ship lock has double sides and 5 blocks, which is the only one in the world and was officially opened to traffic in 2004.

Function

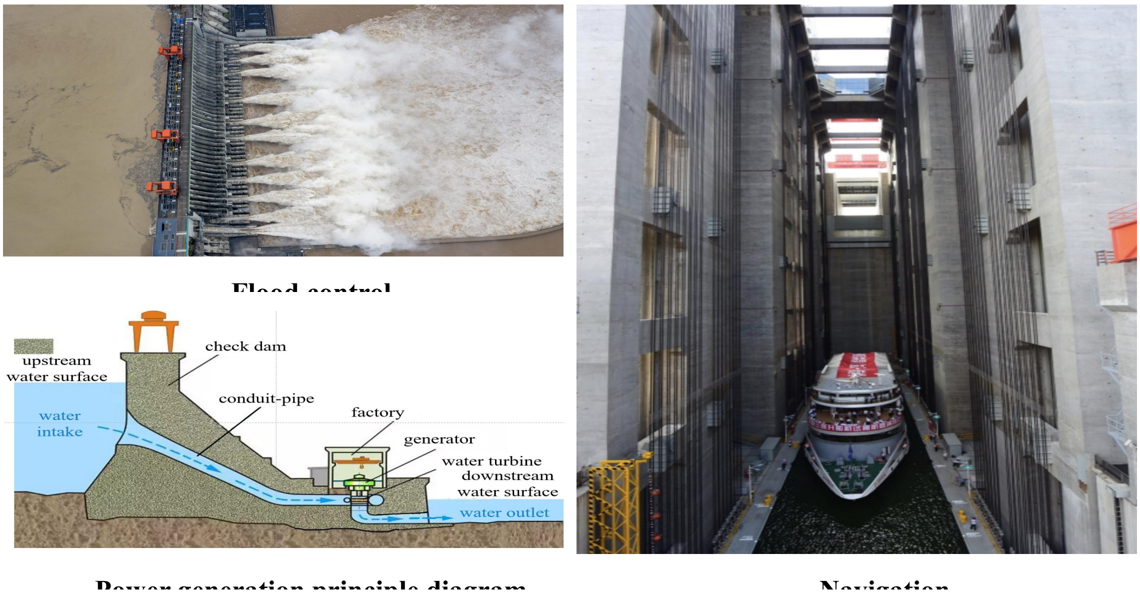


Fig. 16 Three Gorges Water Control Project Function and Power Generation Principle Diagram

- **Flood control**

The main function of the Three Gorges Reservoir for flood control is peak regulation and storage. When upstream flood peaks arrive, the reservoir can store the excess water volume that exceeds the downstream safe discharge capacity, ensuring a safe flow rate downstream. The total storage capacity of the Three Gorges Reservoir is 39.3 billion cubic meters, and the effective flood control capacity is 22.15 billion cubic meters when the water level is at the normal storage level of 175 meters.

- **Power Generation**

The Three Gorges Power Station has a total of 32 installed units, with 14 units on the left bank, 12 units on the right bank, and 6 units in the underground power station on the right bank. Each unit has a capacity of 700,000 kW. The total installed capacity of the Three Gorges Power Station reaches 22.4 million kW, and its annual power generation capacity reaches 90 billion kW·h, making it the largest hydropower station in the world.

- **Navigation**

After the reservoir is filled, the average width of the Yangtze River in the reservoir area increases to one kilometer, and the depth of the river channel increases to 90~120 meters. Dangerous rapids and shoals disappear, transforming the area into a huge lake of over 1,000 square kilometers. This greatly improves the navigational conditions, enabling unrestricted navigation around the clock. Large vessels of up to ten thousand tons can directly reach Chongqing. The annual capacity for vessel passage has increased from the previous 12 million tons to over 100 million tons. Additionally, transportation costs have been reduced by 35%~37% compared to before.

Landscape

The Three Gorges Dam travel sites were formally opened in 1997 and made the first national 5A tourist attraction in 2002 by National Tourism Bureau, and it is also the first national industrial tourism demonstration area. There are Three Gorges Project Exhibition Center, Tanzi Mountain Park, 185 Park, close-look Park and the Closure Memorial Park in the area. The total area of it is 15.28 km^2.

Fig. 17 Tanzi Mountain

Fig. 18 River Bottom Stone

Fig. 19 Closure Memorial

Fig. 20 Damming Stone

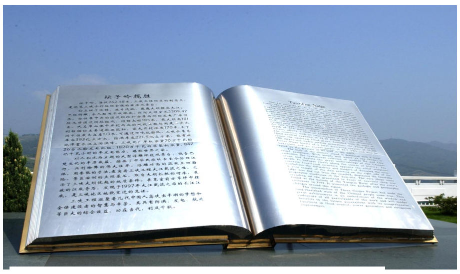


Fig. 21 Silver Version Bible

Fig. 22 Foundation Stone

Responsibilities:

Participants must take responsibility for their safety and the safety of those around them. They are expected to follow all policies and procedures and complete the necessary forms. They must attend any designated information sessions and/or training and provide all required equipment (e.g. enclosed shoes, hats) as instructed.

- Participants **must** carefully read **Informed Risks and Related Matters of Field Trips** and prepare accordingly in advance.
- Participants **must** complete all relevant forms including **Field Trip Responsibility Commitment Form** and **Health Risk Assessment Form** by the date set by the Field Trip Leader;
- Failure to provide adequate information such as relevant medical conditions or emergency contact details will result in the participants not being able to attend the field trip;
- The personal emergency contact details will be included in the field trip documentation and should be available on the field trip.

Health assessment

If a participant has a medical condition that may cause problems on a fieldwork trip, or if they do not feel they are fit enough to take part in fieldwork, they must speak to the Fieldwork Leader before the work begins. Participants should also inform the Field Trip Leader of any medical conditions that arise before departure. If the participant regularly takes medication e.g. diabetes, epilepsy, or allergies, it is recommended that the Field Trip Leader is informed before the symptoms if they are not taking the medication. Participants should ensure that they have adequate medication or means to obtain further supplies during fieldwork.

When attending a field trip, participants should let the Field Trip Leader know if they are having difficulty keeping up with the trip. If a participant begins to feel unwell or injured, he must inform the Field Trip Leader immediately.

Risk assessments and safe work procedures

Risk assessment is an important step in protecting people from harm. In doing this we are complying with the law and more importantly, we are ensuring that the likelihood of causing harm is minimized. The definition of harm at field trips is usually considered to be injury or ill-health but harm can also be damage to property, equipment, or the environment.

safety equipment

Field Trip Procedures, all relevant safety equipment taken on the field trip, where possible, must be:

- of an approved design.
- meet the appropriate Chinese standards for the equipment being used and the activity being undertaken (when appropriate).
- used for its intended purpose and in accordance with the manufacturer’s instructions and where applicable risk assessment / safe work procedures.
- regularly inspected and maintained.

XIV IAEG CONGRESS

ENGINEERING GEOLOGY FOR A HABITABLE EARTH