

# Research on Disaster Damage of Immovable Cultural Relics in China in Flood Season of 2020

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2020 China floods were the worst in more than two decades, causing severe damage to immovable cultural relics. Through a large number of literature collection, the damage relics affected by floods in China in 2020 was summarized and sorted. The damaged immovable cultural relics are summarized into three types: ancient bridge, ancient architecture and ancient site. The typical damaged cultural relics, such as Zhenhai Bridge, Rainbow Bridge, Wind-rain Bridge, Guanyin Pavilion and Xiangyang City Wall, are listed in the form of pictures and texts. Finally, the problems existing in the protection of immovable cultural relics are summarized, and three conservation suggestions are put forward.

**Keywords:** 2020 China floods, the flood disaster, Immovable cultural relics, the damage

## 1. Flood situation in China in 2020

Since early June 2020, heavy rains caused by the rainy season have severely affected a wide area of southern China, including the Yangtze River basin and its tributaries<sup>1</sup>). During the main flood season in July, rainfall and flooding spread across central and eastern China and were described as the worst since 1998<sup>2</sup>). By the end of June, floods had displaced 744,000 people in 26 provinces, with 81 of them missing or dead, according to China's Ministry of Emergency Management<sup>3</sup>). As of August 13, floods had affected 63.46 million people, with direct economic losses of 178.96 billion CNY, 12.7% and 15.5% higher than the average levels from 2015- 2019, respectively; 219 people were found dead or missing, and 54,000 houses collapsed, 54.8% and 65.3% lower than the average for 2015-2019, respectively<sup>4</sup>). China's Ministry of Water Resources said a total of 443 rivers across the country were flooded, with water levels in 33 of them reaching record levels<sup>5</sup>).

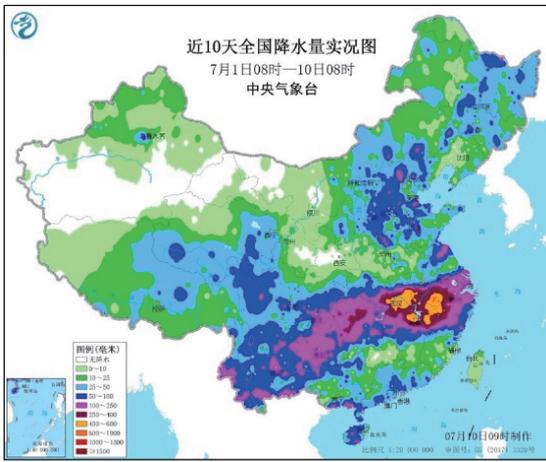


Fig. 1 The actual rainfall in the main flood season<sup>6)</sup>

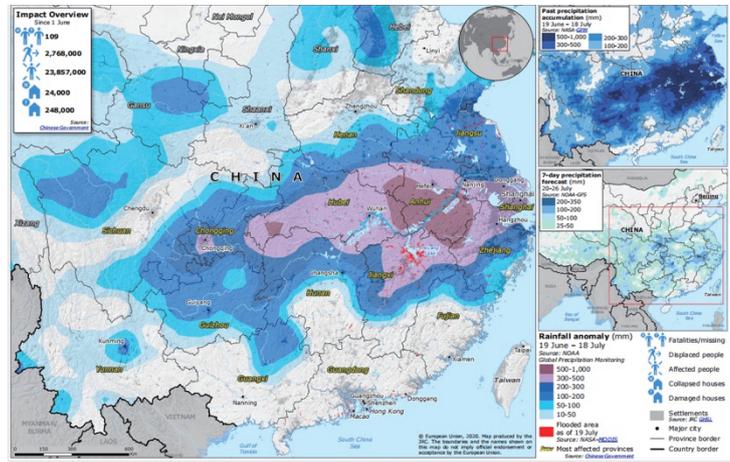


Fig. 2 Rainfall analysis chart of the Yangtze River Basin<sup>7)</sup>

## 2. The flood disaster damage of China's immovable cultural relics in 2020

Influenced by heavy rainfall in the flood season of 2020, severe floods, landslides, mudslides and other geological disasters occurred in many places, and some cultural relics were seriously damaged. According to statistics from the National Cultural Heritage Administration (NCHA), as of July 16, more than 500 immovable cultural relics in 11 provinces have been damaged by floods to varying degrees, including 160 in Jiangxi, 144 in Anhui, 62 in Hunan, 41 in Sichuan, 35 in Guangxi and 31 in Hubei., 76 key national cultural relics and 187 provincial cultural heritage sites have suffered damage of varying degree<sup>8)</sup>.



Fig. 3 Distribution map of immovable cultural relics damaged by flood in each province (drawn by the author)

## 3. Damage types of immovable cultural relics

Ancient Bridges, ancient architectures and ancient sites were badly damaged, according to a survey of damage to immovable cultural relics during the flood season in 2020. These include: ①More than 70 Bridges in 11 provinces were damaged, including the Tunxi Zhenhai Bridge in Huangshan, Anhui, the Qinghua Rainbow Bridge in Wuyuan, Jiangxi and the Matouxi Wind-Rain Bridge, which are the key national cultural protection units;②The Guanyin Pavilion in Ezhou, the Wu Yang Branch Temple and other ancient buildings are also facing a severe test due to the invasion of floods. ③Ancient tombs, ruins and cliff statues were damaged to varying degrees by floods and landslides, and some ancient city walls cracked and loosened in many places.

## (1) the ancient bridge

### a) Tunxi Zhenhai bridge in Ming Dynasty

Zhenhai Bridge was built in 1536, the 15th year of the reign of Emperor Jiajing of the Ming Dynasty. The bridge went across the Heng River, and had a total history of more than 400 years. The bridge was 133 m (436 ft) long and had 15 m (49 ft) wide. It is a stone arch bridge with six-pier and seven-holes<sup>9)</sup>. Zhenhai Bridge is one of the rare large stone arch Bridges of Ming Dynasty in Anhui Province, which is of high historical, cultural and scientific value. Due to continuous heavy rainfall, especially the flood caused by continuous rainstorm from the evening of July 6 to the morning of July 7, 2020, due to continuous scouring and long-term high water level soaking, Zhenhai Bridge, one national-level cultural relics preservation unit, was washed away by the flood at about 9:50 a.m. on July 7, 2020, and the bridge components and stones were scattered in the water<sup>10)</sup>.

The main purpose of this restoration is to continue the memory of history and culture and the inheritance of traditional skills. In order to maximize the original appearance of Zhenhai Bridge after maintenance, as well as the stability and durability of the bridge structure, modern technology has been used to optimize the maintenance of the foundation, and bored piles and concrete bearings were used in the restoration project, according to the report. The pier and the bridge deck still use the original masonry structure. How to combine traditional technology with modern technology has become the main problem that the expert group needs to solve.



Fig. 4 before the damage



Fig. 5 in the renovation<sup>11)</sup>



Fig. 6 before the damage<sup>11)</sup>



Fig. 7 after the damage<sup>11)</sup>

### b) Rainbow Bridge in Wuyuan County

Rainbow Bridge, an 800-year-old covered bridge in Qinghua Town, was submerged by more than one meter. Rainbow Bridge adopts the structure of four piers, five holes, five pavilions and six corridors. Among the stone piers, the sharp part, commonly known as the "swallow mouth", can reduce the impact of floods on the piers<sup>11)</sup>. Due to the huge impact of the flood, the deck (two corridors and one pavilion) between the east approach bridge and the No.2 pier of the rainbow bridge was washed away, while the rest of the bridge body was basically intact, and the submerged "swallow mouth" pier was still intact. At present, the main structure of the ancient bridge piers is basically well preserved, with only some wooden buildings and the surface layer of the bridge deck damaged, which is not difficult to repair in the later stage<sup>12)</sup>.

After the disaster, Wuyuan in Jiangxi Province issued a "Rainbow Order" to search online for logs washed away by floods. So far, more than 70 lost wooden components have been recovered. Focusing on the repair policy of "Conservation First, Rescue First, Rational utilization, and Strengthened management", traditional techniques will be adopted to ensure the integrity and authenticity of the ontological structural system of the Rainbow Bridge to the greatest extent, so as to truly "Repair the old as the old". This repair will carry on the comprehensive repair to the bridge deck brick wood structure, the partial restoration, the bridge pier and so on carries on the reinforcement.



Fig. 8 before the damage



Fig. 9 in the renovation<sup>13)</sup>



Fig. 10 after the damage<sup>13)</sup>



Fig. 11 after the damage<sup>13)</sup>

### c) Matouxi Wind-Rain Bridge

Matouxi Wind-Rain Bridge is located in Wangjiaping Town, Zhangjiajie City. It was built in the late Ming and early Qing dynasties and has a history of more than 300 years. Matouxi Wind-Rain Bridge is a typical Tujia folk architecture with two holes and three piers shingle structure<sup>14)</sup>. In the early morning of June 13, torrential rain and mountain torrents surged. Near 10 a.m., the 300-year-old bridge collapsed and was engulfed in the flood, leaving its lone piers<sup>15)</sup>. After the disaster, the villagers spontaneously salvage, and the original components such as keel and pier stone will be used for future restoration.



Fig. 12 before the damage



Fig. 13 before the damage<sup>16)</sup>



Fig. 14 after the damage<sup>14)</sup>



Fig. 15 after the damage<sup>14)</sup>

## (2) the ancient architectures

Ancient architectures collapsed seriously. Many traditional architectures in traditional villages cannot be effectively protected and are in a state of natural decadence with aging and empty-nesting. Under the rainstorm, the original rammed earth walls were soaked and eroded by the rain, and the rickety wooden structures collapsed one after another. The old street dwellings in many places were damaged in many places during the rainstorm. Some houses collapsed, the colored paintings of roof ridges and eaves fell off, the street drainage was not smooth, the foundation was seriously eroded, and the important cultural relics such as ancient buildings and ancient dwellings were eroded by the heavy rain and the surging river, and the cultural relics were seriously damaged.

### a) Guanyin Pavilion, Ezhou City, Hubei Province

It is known as the "first pavilion of the Yangtze River" in Hubei Ezhou Guanyin Pavilion, is the only temple on the Yangtze River. Ezhou guanyin pavilion sits east to west, standing against the water, stone, brick, wooden frame structure pavilion type building, the pavilion is 24 meters long, 10 meters wide, 14 meters high. The Pavilion has one pavilion, two halls and two floors, a total area of more than 300 square meters<sup>17)</sup>. The damaged parts of Guanyin Pavilion mainly include the wooden columns inside the pavilion, the white grey stone walls and the red roof beams inside the temple. Among them, some degree of corrosion appeared after the wood column was soaked by river water, and some of the coating on the wood column peeled off. White grey stone wall inside the temple also suffered river water corrosion, stone wall outside the surface of the protective layer was destroyed. The tie brushed in red pain also have been came off.



Fig. 16 before the damage



Fig. 17 after the damage<sup>18)</sup>

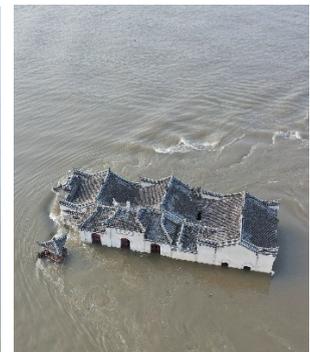


Fig. 18 after the damage

### (3) the ancient sites

Xiangyang ancient city wall, with a total length of 7.33 kilometers, was announced as a national key cultural relics protection unit in 2001<sup>19)</sup>. The existing city wall was basically built in the Ming Dynasty, with bricks outside and rammed earth inside. Due to long-term rain erosion and penetration, on 20 June 2020, the central wall of the eastern section of Xiangyang City Wall (about 150 meters to the south of the east gate) partially collapsed, with a length of about 10 meters. After the disaster, the restoration began with the removal of collapsed bricks and rammed earth. Then began to repair and reinforce the damaged parts of the ancient city wall, additional reinforcement measures were added to the foundation of the collapsed section of the city wall<sup>20)</sup>.



Fig. 19 before the damage



Fig. 20 after the damage<sup>19)</sup>

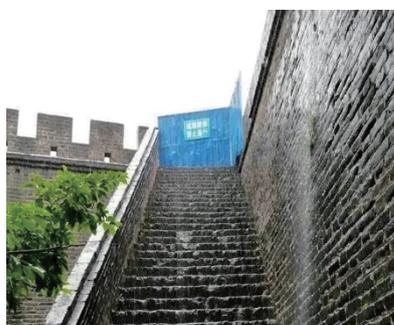


Fig. 21 after the damage<sup>19)</sup>



Fig. 22 in the renovation<sup>21)</sup>

## 4. Problems and conservation suggestions in the protection of immovable cultural relics

### (1) Existing problems

a) Cultural relics themselves are weak in disaster prevention and mitigation

In history, many cultural relics were destroyed by disasters or have been reconstructed after several disasters. The Tunxi Zhenhai Bridge was washed away in this flood, has been rebuilt and rebuilt for many times in history due to floods. Cultural relics are distributed in complex areas, many of which are located in mountainous areas, rivers, lakes and valleys, and are greatly affected by natural geological disasters. At the same time, China's cultural relic buildings are mostly wooden frame structures, and the main building materials are wood, brick and tile, etc., especially in some revolutionary sites, most of them are ancestral halls and residential buildings, which are of low grade and easy to be damaged in natural geological disasters.

b) Research on cultural relic disaster prevention and mitigation technology is insufficient

China's cultural relics, construction is focused on the research of the protection of cultural relic building construction pattern, shape, structure, etc., on cultural relics itself has the function of the disaster, attention is not enough, failure to form a system of cultural relics of the disaster prevention concept and technological system, cultural relic restoration disaster prevention and mitigation measures in the lack of specific guidance, many cultural relics have not played their function of disaster prevention and resistance well.

c) The disaster prevention and mitigation system of cultural relics is not perfect

The lack of a sound disaster prevention and mitigation system to guide the cultural relics prevention and mitigation work of units at all levels to continue before, during and after disasters. Disaster prevention and mitigation of cultural relics in some places have not received due attention, and the prevention and mitigation of cultural relics has not been included as an important and special part of the local natural geological disaster monitoring and early warning and disaster prevention and mitigation system. At the same time, there is a general shortage of personnel, insufficient supplies and equipment for disaster prevention and reduction, and a lack of effective professional rescue and relief forces. Faced with major natural geological disasters, the emergency disposal of cultural relics and the rescue and relief work appear to be beyond our capacity.

## **(2) Conservation suggestions**

a) Establish a disaster prevention and mitigation system with preventive conservation as the core

We will guide local governments to make disaster prevention and reduction of cultural relics an important part of the disaster prevention and reduction system. The concept of preventive conservation of immovable cultural relics is put forward to reduce the risk of natural disasters in three stages: risk identification, risk assessment and risk disposal. In the event of major natural disasters, departments should strengthen coordination and cooperation, strengthen comprehensive monitoring of multiple disasters, forecast and early warning, information sharing, and coordination in emergency response, so as to enhance the overall capacity of cultural relics to prevent and mitigate disasters.

b) Improve the emergency plan for disaster prevention and mitigation of immovable cultural relics

We will further improve the emergency response mechanism, disaster prevention and mitigation of cultural relics around according to the practical guidance for disaster prevention and mitigation of cultural relics and disaster relief emergency plan, improve the disposal of cultural relics, information report, post-disaster repair and restoration and a series of emergency disposal procedures and measures to carry out emergency training and drills, strengthen the cultural security emergency disposal ability.

c) Give play to the disaster prevention function of cultural relics themselves

We will conduct research on cultural relics, explore the unique disaster prevention systems and functions of ancient cities, ancient villages and ancient buildings, and give full play to their important role in disaster prevention and reduction. For example, the flood control function of the ancient bridge itself, the seismic function of the ancient building itself, etc.

## **5. Conclusion**

Immovable cultural relics, due to their characteristics of immovable, non-renewable, complex types and long-term exposure to the natural environment, are at high risk of being damaged and destroyed in the face of major natural disasters. In 2020, China's immovable cultural relics were damaged by floods, which alerted cultural relic workers worldwide not only to fully understand the importance and urgency of cultural relic rescue and protection work in post-disaster recovery and reconstruction. At the same time, all units should actively coordinate and improve the preventive conservation technology system of immovable cultural relics, and start from each stage of disaster to reduce the damage of natural disasters to immovable cultural relics.

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