

Study on the Disaster Prevention Countermeasures about Historic Blocks in China

—Taking A Yi Dun District of Yi Ning in Xingjiang province as the example

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Yi Ning A Yi Dun, Xinjiang located in the northwestern region of China has a well-preserved and valuable historical site. The most building structures are based on brick-wood which is often suffered by natural disasters such as earthquakes, fires, floods, and windstorm. According to the records, there were many natural disasters in Yi Ning area and based on current conditions in terms of disaster prevention, the existing environment and procedure is unable to prevent future nature disaster attack. In order to preserve these valuable historical relics, this paper will apply classification methods and analyze vast amounts of data targeting to two areas of A Yi Dun which are mainly suffered by earthquake and nature fires and propose a specific strategy to prevent these that also can be referenced for disaster prevention in urban historical districts in other countries.

Keyword: Historical block, Heritage, Disasters, A Yi Dun district, Disaster prevention

1 Basic overview

(1) Location overview

Yi Ning City in Xinjiang is located in the northwestern part of China (Fig.1), Kazanqi Area is located in Nan Shi District, Yi Ning City, Xinjiang province (Fig.2), and A Yi Dun Historical Street District is located in Kazanqi District, Yi Ning City(Fig.3). A Yi Dun Historic District is located in the northwestern corner of Kazanqi District, with Sheng Li Street as the boundary in the north, Ili 8 Lane in the south, Guo Yuan Street in the west, and Ili Street in the east after widening. The area covers an area of approximately 36 hectares and a core conservation area of approximately 7.8 hectares.



Fig.1 position of Xinjiang province in China (source: self-portrait)



Fig.2 position of Kazanqi area in Xinjiang (source: self-portrait)



Fig.3 position of A Yi Dun district in Kazanqi area (source: self-portrait)

(2) Historic blocks and architectural features

Street is an extremely important aspect in the historical block of A Yi Dun. The spatial scale of the streets is appropriate, and the functions are complex and diverse. In addition to the transportation function, it is also suitable for commercial activity and communications between neighbors.

The architectural style of A Yi Dun Street is changeable, and the types of form are rich. The building structure is mainly brick and wood structure. The design foundations for the bases, doors, windows, verandahs, roofs, cornices, and gates have been combined for many years to create experience and decorative arts, forming a suitable local architecture with strong ethnic characteristics. (Fig.4)




| | | |
|--------------------------|---|--|
| Base | Due to the fact that there is much rain in the area in autumn and the amount of snowfall in winter is large, the form of residential areas gradually evolves into a high platform. |  |
| Doors and windows | The doors and windows of the houses are all wooden, with ventilation and lighting, and the function of indoor and outdoor communication. At the same time, it is also one of the focal points of residential building decoration. |  |
| Veranda | There are two types of flat roofs and sloping roofs in modern representative residential houses. One of the four slope roofs is influenced by the Russian architectural style. |  |

Fig.4 Architectural features analysis

(source: self-portrait)

(3) Overview of historical and cultural heritage

There are strong ethnic architectural features in the Kazanqi area, with 16 cultural relics protection units and cultural relics buildings, 43 key historical buildings places, A Yi Dun Historic District has 9 key historic buildings. (Table 1) Each architectural yard has its unique historical value, and some of these buildings are in urgent need of rescue and repair.

Table1 The statistics of the historic buildings of A Yi Dun

| Number | Serial Name | Category | Position |
|--------|---|-----------------------|----------------------------------|
| 1 | The historic building yard of YN-LS-012 | Traditional residence | No. 27, A Yi Dun street. |
| 2 | The historic building yard of YN-LS-013 | Traditional residence | No. 29, A Yi Dun street. |
| 3 | The historic building yard of YN-LS-014 | Traditional residence | No. 3, lane 4, A Yi Dun street. |
| 4 | The historic building yard of YN-LS-015 | Traditional residence | Orchard street |
| 5 | The historic building yard of YN-LS-016 | Traditional residence | No. 7, lane 4, A Yi Dun street. |
| 6 | The historic building yard of YN-LS-017 | Traditional residence | No. 2, lane 4, A Yi Dun street. |
| 7 | The historic building yard of YN-LS-020 | Traditional residence | Lane 4, A Yi Dun street. |
| 8 | The historic building yard of YN-LS-021 | Traditional residence | No. 12, lane 4, A Yi Dun street. |
| 9 | The historic building yard of YN-LS-022 | Traditional residence | No. 25, lane 4, A Yi Dun street. |

(Source: Yi Ning's conservation plan of historic cities)

2 Overview of Historical Disasters

The types of disasters that affect safety include: earthquakes, floods, wind disasters, fires, and other disasters. For A Yi Dun History Street, a comparison of the types of disasters found that earthquake is the most influential factor. (Fig.5)

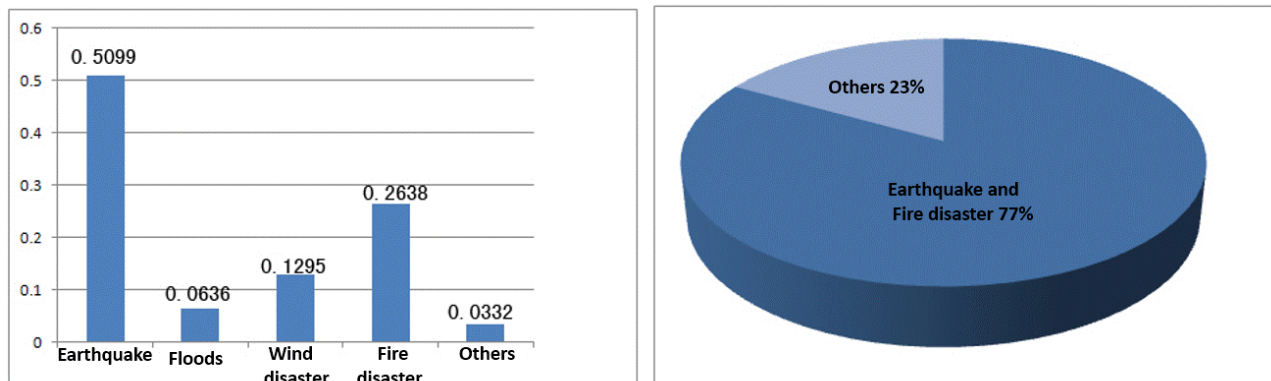


Fig.5 The proportion of safety risk factors
(source: self-portrait)

(1) Overview of Earthquake occurrence

Since the 1970 earthquake records, there have been 375 earthquakes of magnitude 3 or higher recorded in the region, including 1 earthquake of magnitude 6.1, Six earthquakes above the level 6, 41 earthquakes of magnitude 4.1-4.9, 327 earthquakes of magnitude 3.0-3.9, the largest earthquake is the Zhaosu 6.1 earthquake on December 1, 2003, and it is a shallow earthquake. According to earthquake trend research, it is predicted that there will be a magnitude 7 earthquake in the next 50 years.

(2) Overview of the occurrence of floods

According to records, in the 30th year of the Republic of China (1941), the village of Yi Ning Tuohu Lake was flooded and the drainage dike was damaged by more than 1.5km. 1041.25 acres, 11 households. In August 1954, the water of the Ili River steeply rose to 1400 m³/s (generally 200 m³/s) and flooded into the urban area. On May 27, 1963, the Ili River flooded. From February 28th to April 4th, 1966, Ili directly under the jurisdiction of counties and cities was the most rainy and longest duration in February, March and April in recent 60 years. The precipitation in Yi Ning City was 43mm.

(3) Overview of occurrence of wind disaster

According to " Yi Ning City Chronicle", in October 1959, the warehouse of Yi Ning City Material Supply Bureau which was over 700 square meters, was blown down by strong winds (maximum wind level 9). From September 20 to September 21, 1964, Yi Ning City scraped more than ten blasts, blowing more than 50 city lines and 20 poles, interrupting circuits and conversations. On September 20, 1965, there were 12 gales in Yi Ning City, and the power lines hung up and the power was cut off for 1-2 weeks.

3 Disaster tolerance assessment

(1) Earthquake tolerance

Ah Yi Dun area has a high density of buildings, a dense population, and uneven quality of construction. The buildings with better quality are mostly brick-wood structures or brick-concrete structures. However, those houses were not well designated by professional design from prevention earthquake perspective and

merely meet the 7-degree seismic intensity requirement of Yi Ning. Most of the buildings with poor quality are civil structures (Table 2), which have the risk of collapse and have a large potential safety hazard. In addition, the earthquake risk in the A Yi Dun historical block also includes the lack of effective suspension sites and reasonable evacuation routes.

Table2 Urban building classification statistics in Yi Ning

| Structure Type | Total Area (ha) | Percentage (%) |
|-------------------------|-----------------|----------------|
| Brick-timber structure | 303.12 | 35 |
| Brick masonry structure | 398.3 | 46 |
| Reinforced concrete | 69.29 | 8 |
| Civil structure | 95.27 | 11 |
| Total | 866.07 | 100 |

(Source: Yi Ning's city earthquake disaster reduction)

(2) Flooding capacity

Yi Ning City's average annual temperature is 7.5°C-9.7°C, the coldest 1-2 month average temperature is -7.3°C, and the hottest July-April mean temperature is 15-17°C, extreme maximum temperature is 40.2°C, lowest is -43.2°C, average temperature difference between day and night is 9.3°C, extreme temperature difference is 24.7°C, diurnal difference between day and night and seasonal temperature, easy to accumulate atmospheric water in the summer, the formation of heavy rain opportunities, resulting in heavy rain Flash floods.

A Yi Dun Historic District is adjacent to the bank of the Ili River and the Back-beach Water System flows through the river (the total length of the river system is 18.5 km.1.3m³/s). If the weather is affected by heavy rain, the water levels in the Ili River and Back Beach will rise, and the drainage system in the old block cannot satisfying the corresponding needs can easily cause flood disaster risks.

(3) Wind disaster tolerance

Yi Ning has strong winds throughout the year. The average number of gales over Grade VIII and above in 3-5 months reached 7.5 days, with a maximum of 28 days. It accounted for 79% of the total over 8 years of the year. The extreme maximum wind speed in May was 27.5 m/s, and the extreme maximum wind speed in autumn was 40 m/s. Yi Ning has brought great wind hazards.

The public facilities in A Yi Dun Historical District are aging and backward, and some of the buildings are of poor quality and do not have wind resistance. (Fig.6)



Fig.6 The building is urgent to rescue and repair

(source: self-portrait)

(4) Fire resistance

There are three major problems in the existing buildings in the block: poor fire separation, poor safety evacuation, complex functions, and many hidden fire hazards; construction fire resistance is low, fire load is large, fire facilities are few, and methods are simple. (Fig.7)

In general, the status quo of disaster resistance in neighborhoods is not enough and a series of measures need to be taken to strengthen them.



Fig.7 Current houses
(source: the paper of Lina Zhang)

4 Disaster Prevention Strategies

Through the analysis of the weights of the disaster factors in the A Yi Dun historical block area, we can see that the primary hazards affecting the safety of A Yi Dun historic blocks are mainly earthquakes and fires. Therefore, the design of the disaster prevention and mitigation of the A Yi Dun historical block mainly includes three Aspects: (1) The earthquake strategy; (2) The fire disaster strategy.

(1) The earthquake strategy

Mainly from the improvement of the building's seismic capacity, rational planning of shelter sites, effective combing of safety evacuation routes, appropriate reduction in building density and update the layout of the form. (Fig.8)

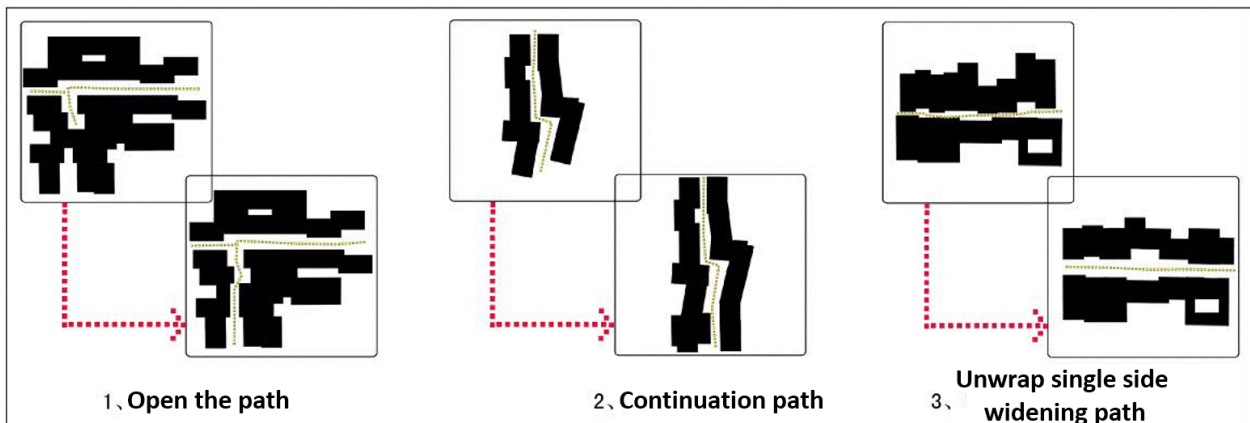


Fig.8 Block the road reconstruction
(source: self-portrait)

(2) The fire disaster strategy.

The construction of A Yi Dun Historical Street is mainly brick and wood structure. The brick walls are load-bearing walls, and the roofs, doors and windows, and outside corridors are generally wooden structures. Improve the fire resistance of buildings, add fire-fighting equipment, rationalize the layout of functions, and build a safety evacuation system. (Fig.9)

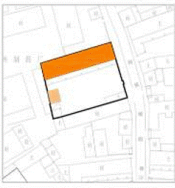
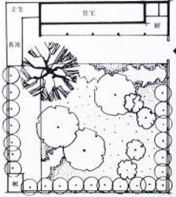


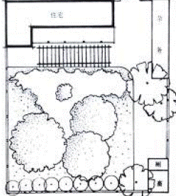


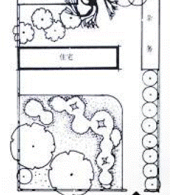

| Case name | House layout type | Courtyard range | Courtyard layout | Real photos |
|----------------------------------|-------------------|---|--|---|
| No. 2, lane 4, A Yi Dun street. | "—" Font |  |  |  |
| No. 3, lane 4, A Yi Dun street | "U" Font |  |  |  |
| No. 12, lane 4, A Yi Dun street. | Compound |  |  |  |

Fig.9 Courtyard space analysis
(source: self-portrait)

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