

Investigation and Research on Building Diseases in Yueliangdi Village, Yinggebao Township, Mulei Based on GIS and Infrared Thermal Imaging Technology

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Abstract. In this paper, the representative buildings built in different periods of the village are observed and their types and conditions are recorded according to the phenomenon that the defects and diseases of the local historical settlements are increasingly serious due to blind transformation and excessive commerce in the protection work of moon village in Mulei County, Xinjiang. Then, the main building diseases of moon village are studied based on the theory of architectural pathology and GIS platform. The coupling relationship with local microclimate, and the degree of disease of the village houses are classified into three categories: light, medium and severe diseases. Based on the analysis of the change of macro climate and local microclimate conditions in the South and north of the East Tianshan Mountains, it is concluded that the main reason for the defect is the damp disease. The infrared thermal imaging technology is introduced to analyze the damp disease in the settlement, and the preliminary judgment method of the damp disease is obtained, which should be paid attention to in the future protection work.

1 Historical evolution and geographical and climatic conditions of yueliangdi village, yinggebao Township



Fig1. Main village pattern

1.1 historical evolution of yueyuedi Village

Yueyuedi village, yinggebao Township, Mulei Kazak Autonomous County, Changji Hui Autonomous Prefecture, Xinjiang, is located in the northern foot of the East Tianshan Mountains and the west edge of the Turpan Hami basin. It was built in the late Qing Dynasty and the early Republic of China. It has a history of 100 years. It is

named yueyuedi village because the land is cut into crescent shape by the river around the village. Due to its integration of traditional dwellings, folk customs, handicrafts and natural landscape culture, the village was listed in the list of Chinese traditional villages by seven ministries and commissions of the State Council in 2014. It is also one of the most complete traditional villages in Mulei County.

Köppen climate types of China

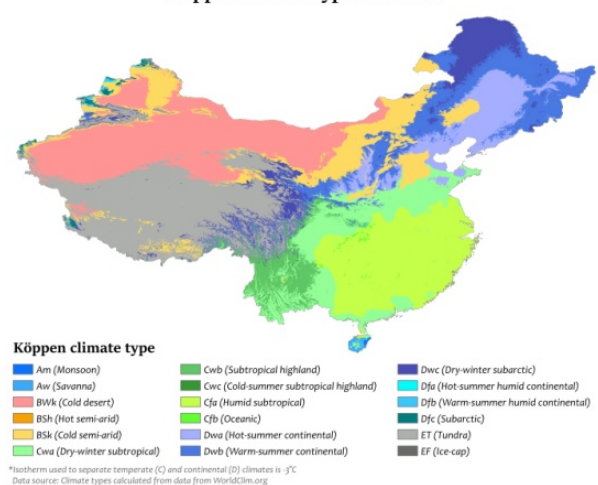


Fig2. China cobain climate partition

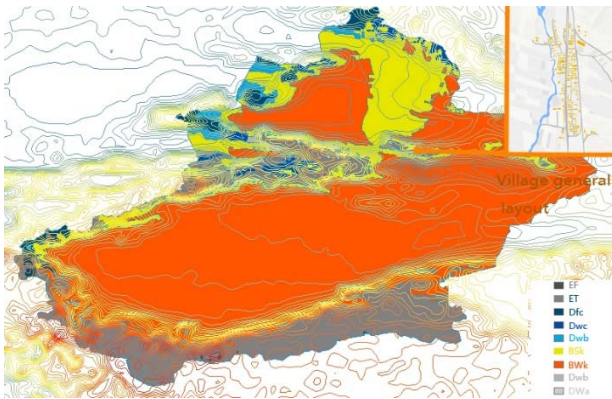


Fig3. Superimposed analysis of The GIS platform of Yuandi Village

Al though the settlement has experienced many years of change and repair, the settlement pattern and features still reflect the characteristics of the village during the initial construction period of the late Qing Dynasty and the early Republic of China^[1], that is, most of the village houses are arranged along the road in order to facilitate contact and communication, and some houses are arranged freely along the river to facilitate water intake. Most of the dwellings in the village are dominated by balang buildingwith a strong Shaanxi Gansu style. Compared with other parts of Xinjiang, such as green tile, yellow clay wall, wooden fence courtyard walland other components, it also tells the common people its origin.

1.2 The geographical and climatic conditions of Yueliangdi Village

In the past, when mentioning the climate in Xinjiang, the general impression of scholars was traditional concepts such as dryness, less rain, and more wind and sand. However, recent studies by geographers have shown that the climate in Xinjiang, especially in the Tianshan Mountains, is changing from warm and dry to warm and wet^[2] And in recent years, the precipitation in mountainous areas has shown an obvious upward trend^[3].

In this study, the author used the Köppen climate zone theory and ArcGIS software to superimpose the Xinjiang Köppen climate zone with Xinjiang terrain contours and the geographic coordinates of Moon di Village and the author's general plane drawn by Google Maps. The analysis showed that Compared with other regions in northern and southern Xinjiang, the climate in Tianshan Mountains is more diverse and complex: the Tianshan Mountains have four types of semi-arid climate, monsoon climate, humid continental climate and tundra climate from low to high altitude. According to the geographic coordinates of Yueliangdi Village, the author judged from Fig. 2 and Fig. 3 that the climate type of Yueliangdi Village is a warm summer humid continental climate (Köppen classification Dfb climate). The main characteristics of this climate are: the coldest The average monthly temperature is below -3°C (27°F), the average temperature for all months is below 22°C (71.6°F), and the average temperature for at least four months is above 10°C (50°F). There is no significant difference in rainfall between seasons, and the data collected by the author verifies this

judgment: Yueliangdi Village ' s monthly average temperature is above 10°C in June, July, August, and September, and its precipitation varies in each season. There is no significant difference. From the collation of meteorological data, the author found that the annual precipitation in Yinggebao Township, where Moondi Village is located, can reach about 400mm, which can reach the standard of semi-humid climate. Because of the climatic conditions, Yinggebao Township and Mu Lei County became one of the main granaries in Xinjiang in the era of planned economy. Based on the above climatic materials, the author proposes that there is a crisis of damp disease at the northern foot of East Tianshan Mountain represented by Mu Lei.



Fig4. General layout of yueyuendi village and selected residential buildings

2 Analysis of the pathological characteristics of residential buildings based on infrared thermal imaging technology

According to this study building pathology classification and diagnostic measures about building disease (4, 5) and settlement survey the scene of the local-style dwelling houses building disease degree settlement houses pathological conditions can be divided into light, medium and heavy at three levels (Table 1), which houses wall paint layer empty drum and flake paint materials classified as "light", the soil cracking and peeling as "in", and structural components such as post stairs will luck receiving gate, luck receiving palace of corrosion cracks and classified as "heavy".

This article selects two representative residential buildings, and introduced the infrared thermal imaging study, from the village general layout (Fig. 4), the two houses in the village of the moon to middle, because of the distance from rivers are ruled out the influence of river foundation, structural system, the same are adobe brick wall structure, Moreover, the two residences were built in the 1980s for local residents to live in for a long time, rather than built in recent five years for tourists to stay in the family hotel. The only difference is that the wall structure of Building 1 is larger than that of Building 2. In terms of wall structure, the outermost side of Building 2 is

painted with a new imitation Clay Facing due to the requirements of landscape protection in recent years. Visual observation, feature evaluation and moisture content measurement were used to investigate the degree of building diseases and pathological analysis on site.



Fig5. Investigation and analysis of Building 1 disease

According to the pathological investigation results of Building 1 (Fig. 5), the east side of the main facade of Building 1 (the part on the right side of Fig. 5 that was not painted with imitation clay finish) was affected by rain and freeze-thaw. Most of the painted wall layer fell off, and the cracking and falling off of the overlying soil layer appeared in some parts. And on the west facade because its new finishes painting and no peeling phenomenon occurred, but under the eaves stylobate up part is a large painting layer infiltration, the phenomenon of empty drum, at the same time the entire building in the stylobate part, the porch pillar and window mouldings cracks occurred in the part of the crack and the material corrosion phenomenon, a few parts in the mould. To choose a building 1 eaves column and girder junction in judgment, temperature cracks found relative to other parts of the surface temperature is lower, while the eaves columns, girders and wooden fang also presents the low temperature condition, and from the hot like part of the larger area relatively visible moisture, shown in the figure shows that in the stylobate internal to the naked eye can't wet condition is still there.

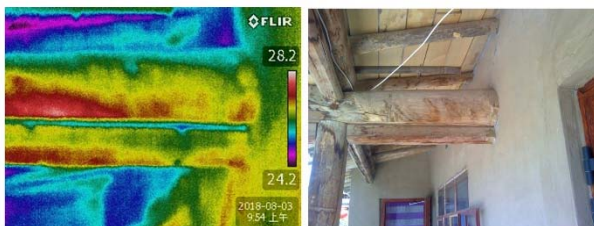


Fig6. Thermal imaging judgment of Building 1 disease

In Building 2, due to the failure to refresh the veneer outside the overlying soil layer, a large number of empty drums and peeling of the painted layer appeared. In addition, the cracking and shedding of the overlying soil layer in this building was significantly more than that in

Building 1, and there were also many cracks on the cornice. As shown in Fig. 3, from the direction of the gable, take the north facade as an example. The overlying earth cracks appear on the gable wall subjected to freeze-thaw action, and some cracks are long, up to 1.1-1.2m, with a width of 10-15mm and a depth of about 15mm. East facade direction its disease situation is relatively serious, appeared in the stylobate turns the soil loss, caused a large number of adobe bricks, exposed the relate to soil moisture stylobate is larger, and the influence of the freeze-thaw action on, at the same time, the border of stylobate and ground in a small amount of moss, the longitudinal wall part of the soil loss relative gable is more apparent, some parts of the fixed effect of oblique cross wood has also exposed long; In addition, the cornice part of Building 2 also suffered from deformation of cornice sealing plate and screw falling off due to rain water, freeze-thaw effect and old disrepair. Building 2, the author find out the typical stylobate and entrance door window frame based on infrared thermal image (Fig. 8), from the infrared thermal image shows: first, the temperature differences on the stylobate in conformity with the stylobate in vertical and horizontal cracks, and relatively intact surface temperature is higher, the more susceptible to cracks and rain, soil water infiltration and shade shadow; The shedding degree of the plastering layer at the base is also shown in the infrared thermal image because of the difference of heat transfer coefficient of different materials (exposed structural members).








Fig7. Investigation and analysis of Building 2 disease



Fig8. Thermal imaging judgment of Building 2 disease

Table1. Disease classification

Severity	Light	Moderate	Heavy
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Pathological name	The surface painting layer is empty and the painting material is peeling off	Overburden falling off and cracking	Cracks in foundation and column	Exposed corrosion of structural components
Pathological symptoms	The internal water seepage, vaporization and expansion of the plastering material cause the material to bulge and deform, and then peel off	Due to the larger variation range of the temperature in the day and night, cracks and shedding of the covering soil of residential buildings are caused by freezing and thawing	The cracks of structural components are caused by moisture and freeze-thaw, and then local looseness and collapse	
Location	Surface coating	General wall and window frame	Lime sand brick platform foundation and exposed wood column	Sand lime brick foundation, cornice and windowsill
legend		 		

3 Analysis of the causes of building defects and diseases in settlements

3.1 Pathological analysis of hollow drum and peeling of wall painting layer

Mentioned above, because the moon is a village at the northern foot of east Tianshan warm humid continental climate in the summer of climate classification (cobain Dfb) climate, the environment temperature difference and large temperature difference between day and night, and precipitation on September 4 - more, combined with the village layout along the river, the surrounding soil moisture content is bigger, makes the settlement building by late spring or early summer rain, soil water and the resulting freeze-thaw effect produced a lot of diseases.

As local precipitation more focused on September 4 -, make settlement in the period of focus is washed by the rain, because of their special civil structure, combined with the roof overburden soil water storage ability is limited, the rain is through the roof into the wall, at this time the moon river surrounding the village just thaw, water reached the peak of my year, makes the soil moisture content is affected by river also showed a trend of rise, soil water down the stylobate to rise due to capillary action, make its damp is in serious condition at the point; Moreover, the temperature difference between day and night in the valley is huge, especially in April, when the daytime temperature is relatively high, the seepage vaporizes and expands, causing the deformation of the painted layer and the empty drum. Because the night temperature can fall below 0°C, the seepage can freeze and expand, causing the peeling layer to break off. As the facade wall of building 1 is shielded by the front eave gallery, the evaporation rate of infiltration rainwater on its

surface is slow, which makes the rainwater penetrate into the painted layer more than other parts, so the empty drum phenomenon is more obvious. The west facade is due to the perennial upward adsorption of soil water, which causes the large area of its painted layer to fall off, and the obvious infiltration marks of its base, and mildew spots also appear in some areas.

3.2 Analysis of cracking and shedding of overburden soil

The cracking of the overburden soil layer in Building 2 is obvious, and the reason of the cracking of the overburden soil layer is similar to that of the peeling of the overburden layer, both of which are caused by rain scouring, soil moisture and freeze-thaw action. However, the cracking and shedding of the overburden soil layer relative to the whitewash soil layer need to go through a slow and long process, which is often the result of years of accumulation.

3.3 Cracks, deformation and erosion of structural members

Cracks are mostly found in the base and columns of the two dwellings, and the pathogenic mechanism is the same as the former two. Deformation of the components from the west side of building 2 verge board found that verge board bending deformation due to more people ignore the maintenance set screw, together with concentrated rainfall make wooden strip infiltration, and then affected by temperature changes and the effect of freezing and thawing, the bending deformation, the verge of building 2 board shall promptly repair, to avoid falling and injuring residents; The exposed corrosion phenomenon of the component is more than that found at the base and windowsill thread foot. The reason for this phenomenon is that the aforementioned cracks have not been treated in

time, which leads to their continuous development and finally causes the external plastering layer mortar to break off.

To sum up, the causes of "light", "medium" and "severe" diseases in Moonland village are related to local climate characteristics and soil moisture caused by rain erosion.

4 Study on infrared thermal image determination method of colony moisture disease

Come to a conclusion from the above analysis, the moon to village settlement main disease with local climate and environment more damp conditions, according to the author's research results before^[6], the introduction of infrared thermal imaging technology for wet disease diagnosis and analysis, as shown in Fig. 9, the author choose at building a stylobate is analyzed, through visual found its most serious stylobate damaged area (turns the soil loss, adobe bricks exposed), as shown in the right yellow area is further proof of the author studied before flooding bricks into a nonlinear relationship between moisture content and moisture distance, and then by the infrared thermal imager and determination of moisture meter, It is found that the seriously damaged area of the platform should be the hottest area in summer and the coldest area in winter, that is, the part of residential buildings with disguised thermal Bridges. At the same time, according to the determination of moisture meter and previous research results, the author can determine the minimum temperature area and the location of the maximum moisture content of the platform moisture disease^[4].

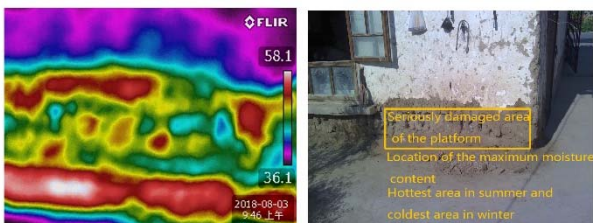


Fig9. Analysis of moist infrared technology of platform base

5 Conclusion

From what has been discussed above, the author based on GIS platform to the moon village, it is concluded after the investigation and analysis of the settlement site is located in the east Tianshan north, soil relative humidity, and the relative average annual precipitation, precipitation is bigger, in the September 4 - are greatly influenced by wet conditions, and the weather gets warmer in April because of the snow melt water run down along the eaves column presents the concentration characteristics, present various wet disease characteristics, according to these characteristics from the perspective of building pathology using infrared thermal imaging technology preliminary quantitative detection of the settlement damp disease research, provide the foundation for the further study.

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