

# Study on the Influence of Urban River on Temperature and Humidity and Its Coupling Relationship

Siqi Liu<sup>1, 2, 3, 4, \*</sup>, Biao Peng<sup>1, 2, 3, 4</sup>

<sup>1</sup>Shaanxi Provincial Land Engineering Construction Group Co., Ltd., Xi'an 710075, China;

<sup>2</sup>Institute of Land Engineering and Technology, Shaanxi Provincial Land Engineering Construction Group Co., Ltd., Xi'an 710075, China;

<sup>3</sup>Key Laboratory of Degraded and Unused Land Consolidation Engineering, the Ministry of Natural Resources, Xi'an 710075, China;

<sup>4</sup>Shaanxi Provincial Land Consolidation Engineering Technology Research Center, China.

## Abstract

**With the development of modern urbanization, people pays more and more attention to the quality of living environment. Rapid urbanization has resulted in a lot of problems. The use of land has been long suffering form low-efficiency and inappropriate. The pattern of land surface directly influences urban environment. Urban river plays an important role on improving living quality, which can mitigate urban heat island and increase air quality. However, the impact of urban rivers on the environment has certain scopes in different context. This paper selected 28 monitoring points in 5 straight lines perpendicular to the river, then qualitatively and quantitatively analyzed the variation of temperature and humidity around urban rivers. The result shows Shichuan River has obvious improvement effect on local temperature and humidity. With the increase of river distance, the effect of cooling and humidification gradually weakened. Within the influence range of urban rivers, the change of distance is only an important factor of temperature and humidity, not a decisive factor, but also affected by topography, nature of underlying surface, vegetation types, types and intensity of human activities and other factors. In the research scope, there is no obvious interaction between temperature and humidity, and the correlation between them is weak.**

## Keywords

**Urban river; temperature; humidity; thermal comfort.**

## 1. Introduction

With the development of urbanization and the increase of urban population in China, the structure and nature of the underlying surface in urban areas have undergone fundamental changes due to a large number of development and construction. More and more natural underlying surfaces (rivers, green spaces and trees, etc.) have been replaced by concrete with low heat capacity and high heat absorption. Urban microclimate refers to the small-scale climate near the surface caused by the change of underlying surface structure. Microclimate mainly refers to the climate from the ground to the height of more than ten meters to 100 meters. By changing the structure of the underlying surface in the area, different microclimate characteristics can be obtained. Urban river is an important natural resource of the city. It can not only provide a good landscape effect for the city, but also reduce the temperature of the city, increase the humidity and ventilation of the city, and play a great role in environmental improvement. In addition, urban rivers have the functions of optimizing the environment, building green ecological corridors, and have special human connotations. Because of some

characteristics of the river itself, the air temperature above the river in summer is low, the humidity is high and the wind speed is high, which has an optimization effect on the local microclimate near the river. Therefore, it is of great significance to use the characteristics of the thermal environment optimization of the urban river to improve the quality of the surrounding human settlements. However, due to the rapid urbanization in China, environmental protection is ignored in the process of development, which makes the area and river basin of urban rivers reduce continuously, resulting in river hardening, river pollution and other problems, thus aggravating the deterioration of urban environment on another level. Therefore, in order to reduce the urban temperature and alleviate the intensity of urban heat island, we should strengthen the protection of urban rivers. When planning and constructing a new city, we should consider the microclimate effect of the river and use the river to cool the city.

With the increasing influence of Xi'an international metropolis, the greater Xi'an Economic Circle plays an increasingly important role in the national economic pattern. Fuping County is located in the middle of Shaanxi Province, the transition zone between Guanzhong Plain and Northern Shaanxi plateau. It is under the jurisdiction of Weinan City. The total area is 1242 square kilometers with a population of 800,000. It is adjacent to Pucheng and Weinan City Center in the East, Lintong district and Yanliang District of Xi'an City in the south, Yaoxian county and Sanyuan County in the west, and Tongchuan City in the north. The scope of this study is located in the south of Fuping County. The project area is located at the gate in the south of Fuping County, about 50km away from Xi'an. It is the transition zone between the high-density central city boundary and the low-density suburban area. It has not only the support of urban functions, but also the infiltration of ecological resources. The geographical location is unique (Figure 1).

Urban water plays an important role in the regulation of local microclimate, and has obvious improvement effect on temperature and humidity. However, the existing research is seriously insufficient. If a large number of field measurement studies are carried out for urban water bodies of different shapes and regions, there are many limitations, such as large cost, long time cycle, and small research scope limited by natural environment conditions.

Through theoretical research, field survey, numerical modeling and numerical simulation, taking Shichuan River as an example, this study mainly discusses and studies the river cooling effect (RCE) and humidification effect of urban water body from the perspective of urban thermal environment, and analyzes the interrelation between micro terrain elements and micro climate changes. Based on the relevant theories of ecology, architectural environment and human settlements environment, this project analyzes the relationship between different land use types, building types, vegetation types, elevation differences and other factors and river cooling intensity (RCI), determines the research scope of influence of Shichuan River, and focuses on the improvement effect of water body on local microclimate in summer. It has innovative significance in water utilization, vegetation development, Riverside architecture design and urban microclimate research. Applying the research results of this project, we can quantitatively analyze the role of water body in improving local microclimate, and provide basis for urban waterfront design and planning, so as to ensure the sustainability of urban economic and ecological development. It is of great significance to reduce the passive regulation of energy consumption, energy conservation and emission reduction, build ecological communities and improve the quality of human settlements.



**Figure 1.** Site-plan of research area in Shichuan river

## 2. Methodology

Gm 1361 digital hygrometer is used for data acquisition in this experiment, which can accurately and effectively identify and detect indoor and outdoor environment temperature and humidity. The improvement of local microclimate in Shichuan river basin is reflected in the decrease of ambient air temperature. We selected 5 straight lines perpendicular to the Shichuan River, and arranged microclimate monitoring points according to different distances, with a total of 28 monitoring points (Figure 2).



**Figure 2.** Monitoring points of 5 lines

## 3. Analysis

Figure 3 shows the temperature change with distance at different monitoring points. The environmental monitoring data were recorded on July 4, July 11, July 15, July 21, July 30, August 5, August 14 and August 24, respectively. In general, with the increase of river distance, the cooling effect gradually weakened. The average temperature drop is between 0.7-1.2°C, which can effectively alleviate the hot summer weather. The lowest value of part of the temperature occurs at the monitoring point 50m or 100m away from the river. Combined with figure 5, the nature of the underlying surface (green belt) and the shade of large trees are the main factors leading to the temperature reduction. Secondly, the terrain and ventilation effect will also affect the local temperature.

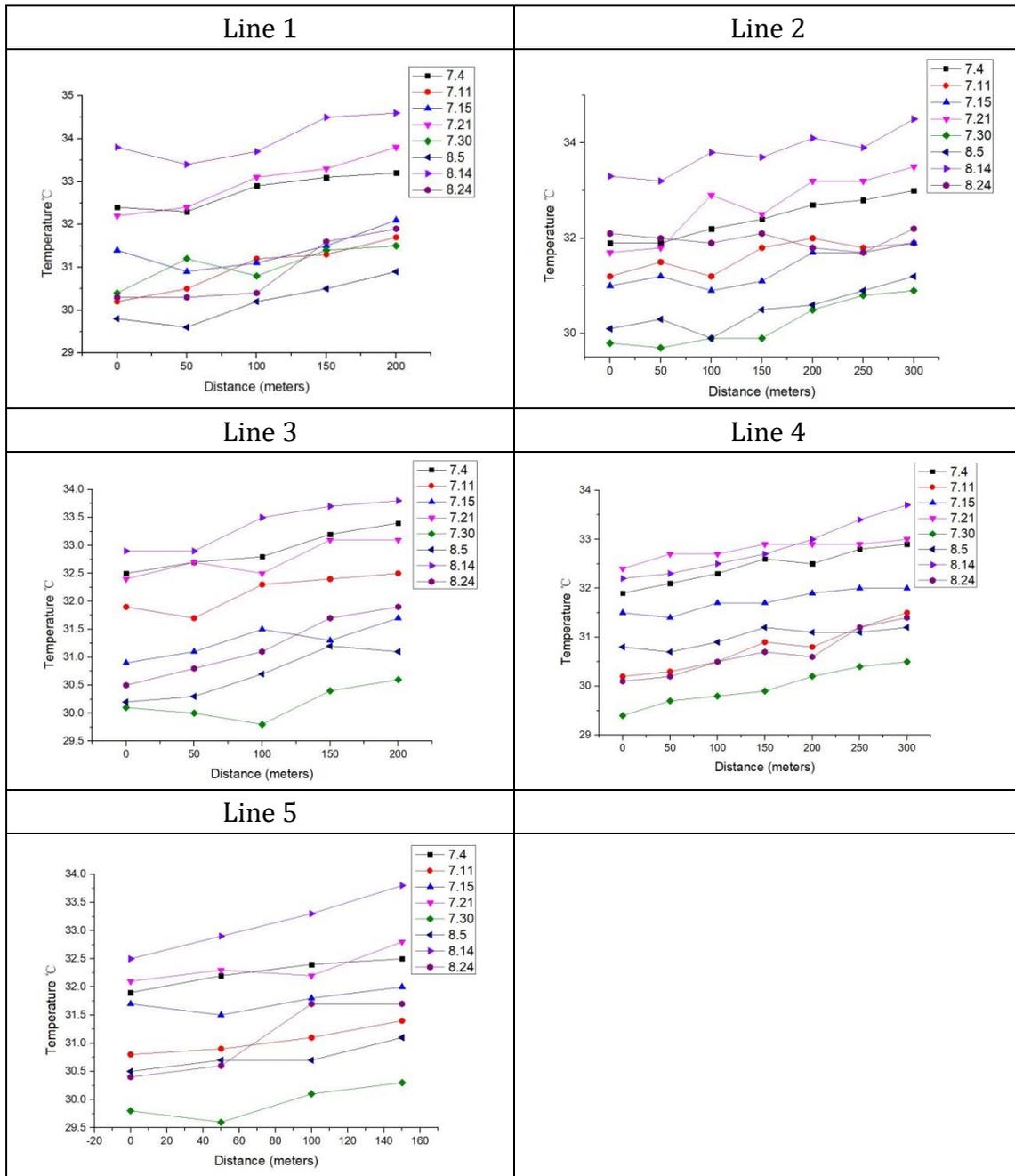


Figure 3. Temperature line charts of 5 monitoring lines in different time

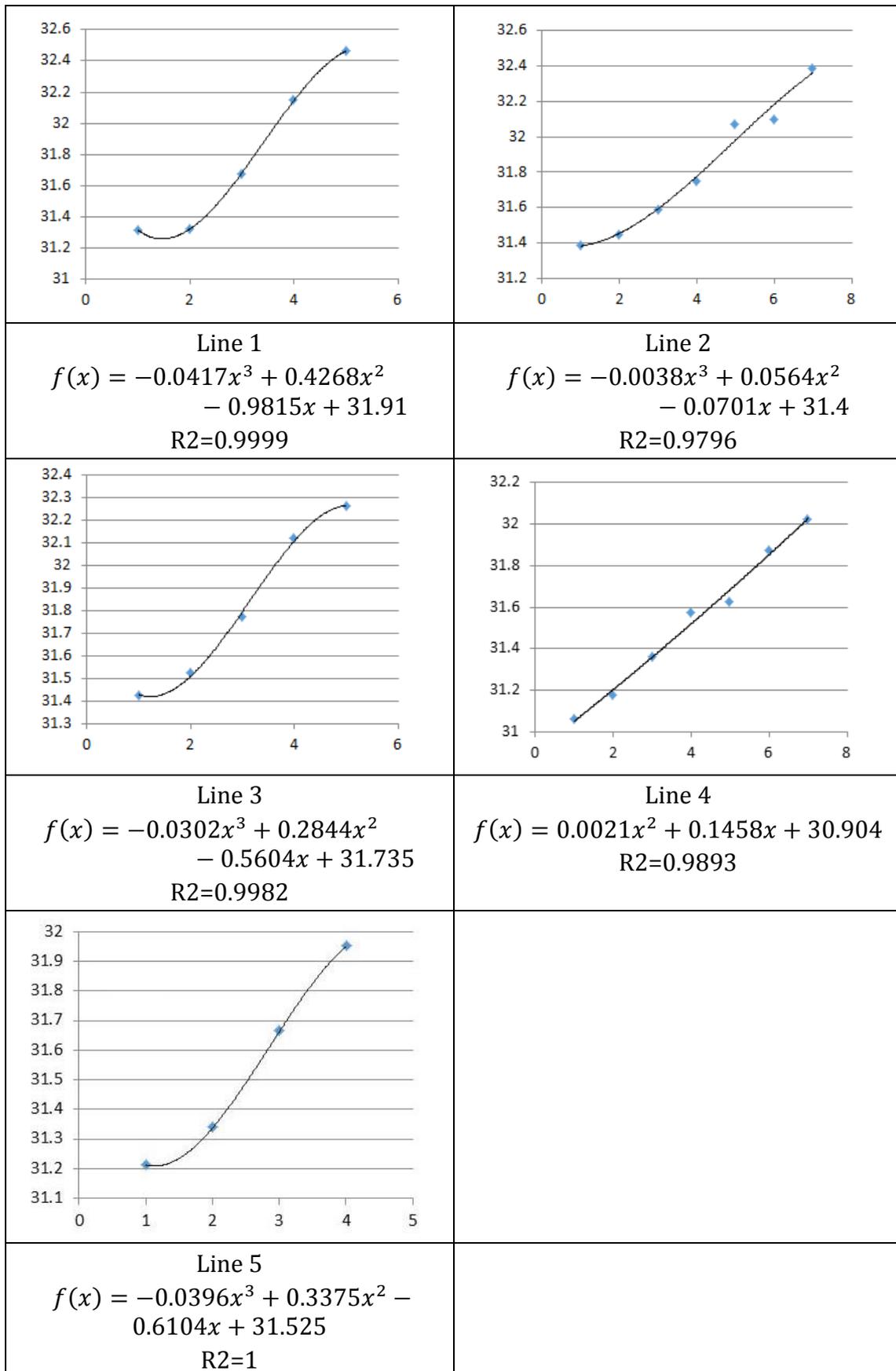
When the external natural temperature is low, the cooling effect of the river is weak. Therefore, the days of hot weather in summer ( $\geq 30\text{ }^{\circ}\text{C}$ ) were selected this time. Through polynomial curve fitting, we will find out the cooling trend and intensity of different straight lines (line 1-5). The specific formula is as follows:

$$f(x) = ax^3 + bx^2 + cx + d \tag{1}$$

Inflection  $x = x_1$

$$RCI = x_1 = \frac{-2b - \sqrt{4b^2 - 12ac}}{6a} \tag{2}$$

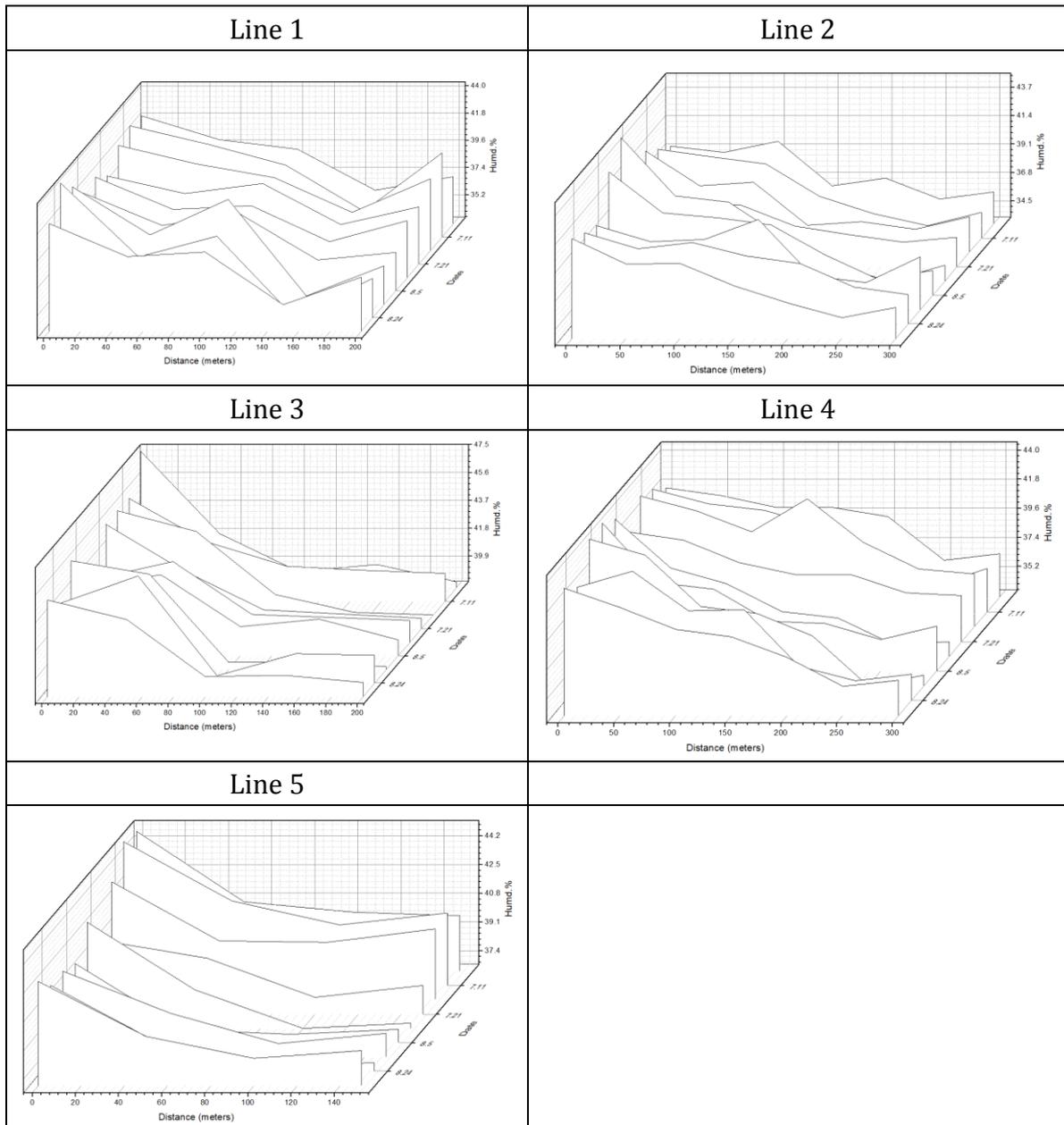
$$RCD = f(x_1) - d = ax_1^3 + bx_1^2 + cx_1 \tag{3}$$



**Figure 4.** Polynomial fitting of temperature in different points

**Table 1.** Correlation reference coefficient and RCI value

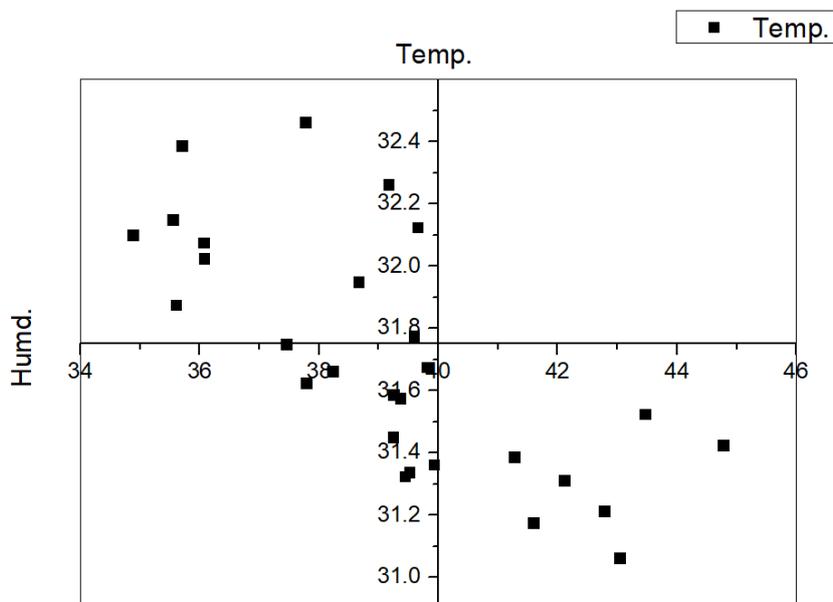
	Line 1	Line 2	Line 3	Line 4	Line 5
a	-0.04	0.00	-0.03	0.00	-0.04
b	0.43	0.06	0.28	0.00	0.34
c	-0.98	-0.07	-0.56	0.15	-0.61
d	31.91	31.40	31.74	30.90	31.53
RCI	5.36	9.23	5.05	/	4.55



**Figure 5.** Humidity waterfall chart of 5 monitoring lines in different time

When the external natural temperature is low, the cooling effect of the river is weak (Figure 4). We calculated the average value of each point at different times, and calculated the cooling intensity based on this (Table 1). The results show that line 2 has the largest cooling intensity, which are 9.23. Line 2 is close to the main road of the county, and each monitoring point is affected by many factors, such as terrain, nature of underlying surface, building form, human activities and so on. Line 1, 3 and 5 are close, 5.36, 5.05 and 4.55 respectively. Since the inflection point of line 4 is not obvious, no calculation will be carried out in this study.

The improvement of local microclimate in Shichuan river basin is also reflected in the improvement of surrounding air humidity. We have selected 5 straight lines perpendicular to the Shichuan River, and arranged microclimate monitoring points according to different distances. By comparing the humidity of monitoring points at different distances in the same straight line, we can find that the humidity along the Shichuan river is significantly higher than the surrounding average value, as shown in Figure 5. According to the measurement results, the closer to the Shichuan River, the higher of the humidity (42.8% on average). With the increase of distance, the humidity gradually decreases and finally tends to be stable. Humidity varies from 4.1% to 6.9%



**Figure 6.** Correlation of temperature and humidity with Central scatter diagram

According to the relevant literature, we can guess that in an ideal environment, if there is only one variable of distance, there must be a high correlation between the change of temperature and humidity. However, for a practical project, the bank line of Shichuan river is winding, the surrounding land types are complex, the underlying surface properties are diverse, human activities are rich, and the terrain in the project area fluctuates greatly. Therefore, as shown in Figure 6, the distribution of monitoring data is relatively scattered, and the decisive factor R2 is 0.5237, which shows that the correlation between these two factors is weak, and the environment in the project area is complex, temperature and humidity are also low. The change is the result of various factors.

## 4. Conclusion

Through field investigation, monitoring and digital simulation, the project analyzes the improvement effect of urban rivers on local microclimate, taking the comprehensive regulation project of Shichuan River as an example. The main conclusions are as follows:

(1) Shichuan River has obvious improvement effect on local temperature and humidity. With the increase of river distance, the effect of cooling and humidification gradually weakened. In the study range of 300 meters, the average temperature drop was between 0.7-1.2°C, and the humidity rise was between 4.1% and 6.9%;

(2) Within the influence range of urban rivers, the change of distance is only an important factor of temperature and humidity, not a decisive factor, but also affected by topography, nature of underlying surface, vegetation types, types and intensity of human activities and other factors;

(3) In the research scope, there is no obvious interaction between temperature and humidity, and the correlation between them is weak.

The project scientifically monitors and analyzes the improvement effect of urban rivers on local microclimate, and qualitatively and quantitatively analyzes the impact of urban rivers on the change of temperature and humidity, as well as the correlation between them. Driven by data, it is clear that local microclimate is a complex system, and its change is affected by many factors of human and nature. Taking Shichuan River as an example, this study combines theory with practice, which has reference value for urban environment improvement and land use optimization. As a representative County in Shaanxi Province, even in the northwest, the development and construction of Shichuan River project in Fuping area will play a guiding role in the comprehensive development of other areas.

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