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Retraction

Retracted: Green Roof Design of Residential Area Based on Sponge City Theory

Wireless Communications and Mobile Computing

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] Z. Shen, "Green Roof Design of Residential Area Based on Sponge City Theory," *Wireless Communications and Mobile Computing*, vol. 2022, Article ID 2861962, 8 pages, 2022.

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Research Article

Green Roof Design of Residential Area Based on Sponge City Theory

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With the acceleration of urbanization, the contradiction between building land and living environment is becoming increasingly prominent. Building sustainable urban architecture has become a topic of great concern, and roof greening has gradually become the inevitable trend of modern architectural development. With the support of sponge city theory, this paper studies the design of green roof in residential area. Firstly, taking roof greening as the research object, this paper makes a preliminary study on its environmental improvement effect by means of experimental research and theoretical analysis and designs the conventional design of roof greening based on the research conclusion. Through the cooling effect experiment, the cooling effect of roof garden in summer is preliminarily studied. It is found that the daily change of temperature of green roof is closely related to solar radiation. With the increase of solar radiation, the temperature rises, and the surface temperature of cement roof and green roof increases. However, due to the difference of heat capacity, the temperature difference of cement roof is the largest, and the change of green roof is the smallest; in the high temperature period in the afternoon, the cooling effect of green roof is the most obvious and enters a stable cooling stage with the passage of time; from 14:00, as the temperature began to drop, the temperature of cement roof decreased rapidly, and the surface temperature of green roof also continued to decline slowly. This surface temperature variation of green roof can form a good cooling surface. Therefore, the green roof plays a positive role in regulating the near ground temperature and protecting the building surface.

1. Introduction

Nowadays, with the rapid development of the city, more and more buildings have sprung up, which not only brings a lot of convenience to people's life but also brings a lot of environmental problems. The contradiction between construction land and greening land is one of the problems. In order to find a way to solve this contradiction, people have turned their attention to roof greening [1–3]. China is a country with a large population and many cities are overcrowded. Under the premise of such a large population density, there is little land that can be used for greening, resulting in the poor environmental level of many cities. In cities where land resources are very precious, if the space on the roof can be used for greening, it can not only save limited land resources but also improve the urban environmental quality and achieve a win-win effect. In the past, greening construction was rarely included in the design scope in China's urban planning and construction [4–6]. Therefore, most of today's urban greening in China are scattered supplementary greening. In addition, a few parks and squares with concentrated green space are difficult to really bear the burden of regulating the urban ecological environment, which requires a new method, and roof greening came into being [7, 8]. The emergence of roof greening can not only save urban construction land but also expand the scope of urban greening. It can bring multiple benefits to today's cities with economic development as the main body. Due to the lack of urban land resources, the cost of greening in today's big cities is quite large, but roof greening solves this problem very well. Roof greening not only refers to greening on the roof of buildings but also directly builds greening on man-made buildings, which is the main difference between it and ordinary ground greening [9–11]. Another feature of roof greening is that the planting soil layer of roof greening is an independent planting soil layer, forming an independent greening unit. In addition to roof construction, there are many forms of roof greening, mainly including wall three-dimensional greening and indoor greening [12]. First of all, roof greening does not need the high cost of land acquisition and demolition. Basically, greening of different scales can be carried out on all roofs; Secondly, roof greening increases the number of green areas, so that more and more people can enjoy a garden like rest environment nearby; thirdly, in some profitable places, roof greening can also bring certain economic benefits [13–16]. As there are many advantages of roof greening, it is of positive significance to social development and environmental protection. In recent years, roof greening has a good development momentum with the encouragement of government policies. The policy of encouraging the implementation of roof greening is the main driving force for its development. Now many cities have allowed the green area of the roof of the community to be included in the green area of the community [17, 18]. There are many such policies to encourage the development of roof greening. Many cities have begun to take roof greening as a part of urban future planning. In large cities with large population density, roof greening will develop at a faster speed.

Sponge city means that the city can better adapt to the changes of the external environment and respond to natural disasters. It is as elastic as a sponge. When the city is faced with flood and waterlogging natural disasters, it can bring rainwater into its own circulation system, "absorb water, store water, and seepage and purify water when it rains, and release and utilize the stored water when necessary." In the process of construction of sponge city, sponge city should fully consider the rational utilization of all links of water circulation system, including natural precipitation, surface water, and groundwater system, and realize long-term sustainable development. The construction purpose of sponge city is mainly reflected in the following points: first, protect the original ecosystem of the city [19]. The maximum protection of water ecological sensitive areas is also the inevitable demand for protecting the ecological environment. Protect the original sensitive ecology, let rivers, wetlands, ponds, and lawns play their original functions, and realize the natural ecological cycle [20]. In the process of construction, the city must reserve enough water circulation areas to conserve water sources, deal with heavy rainfall, and maintain natural hydrological characteristics. Second, emphasize "ecological restoration and restoration." Use ecological technology means and methods to repair and restore the ecosystem that has been damaged in the rapid urban expansion over the years and reserve and allocate a certain proportion of ecological space at the planning level, so as to effectively restore the natural ecological environment. Third, development should reduce its impact on the environment.

The main content of this paper is to design the roof greening of residential area under the sponge city theory, analyze the load of various common roof greening forms, and discuss the basic methods in the design and construction of roof greening. Then, the cooling effect of roof greening in summer and the improvement effect of urban water environment are studied. According to the research conclusion, this paper puts forward the improvement scheme of the conventional design of roof garden, which has important theoretical and practical significance to enhance the environmental improvement effect of the city. Provide convenience for future roof greening designers.

2. Materials and Methods

2.1. Relevant Technical Theory

2.1.1. Low-Impact Development Theory (LID). Low-impact development is a technical means of storm management and nonpoint source pollution treatment developed in the late 1990s. Its purpose is to use divergent and small-scale source control methods in the process of regional development, so as to control runoff and pollution caused by rainfall and maintain the hydrological cycle characteristics before site development, or make the development area as close to the natural hydrological cycle as possible. In general, we can understand low-impact development in both broad and narrow senses. First of all, in a broad sense, low-impact development refers to taking various means to reduce the impact and damage of urban construction on the ecological environment and maintain and restore the natural ecological environment in the process of urbanization. In a narrow sense, low-impact development is a nonchemical technical system that can easily realize urban rainwater collection and utilization. Its implementation focuses on rainwater collection, rainwater purification, nearby utilization, or groundwater recharge. In general, we can understand low-impact development in both broad and narrow senses. First of all, in a broad sense, low-impact development refers to taking various means to reduce the impact and damage of urban construction on the ecological environment and maintain and restore the natural ecological environment in the process of urbanization. In a narrow sense, low-impact development is a nonchemical technical system that can easily realize urban rainwater collection and utilization. Its implementation focuses on rainwater collection, rainwater purification, nearby utilization, or groundwater recharge. The concept of LID development mainly includes the following: (1) control the site rainwater from the source of runoff, and advocate the application of decentralized, small-scale, and interrelated design methods; (2) give full play to the natural purification function of plants; (3) pay attention to the compliance function of the landscape and meet the requirements for rainwater resource management while meeting the landscape design function. Therefore, in a certain sense, we can understand the construction theory of sponge city as a narrow interpretation of low-impact development. The rainwater development system of LID can be shown in Figure 1.

2.1.2. Elastic Landscape Theory. Elasticity refers to the ability to resist disadvantages, including various disasters, negative threats, negative influencing factors, and uncertain factors, etc., which are embodied in climate, pollution, natural disasters, economic impact, cultural obstruction, culture, space, politics and other aspects. Landscape elasticity refers to the

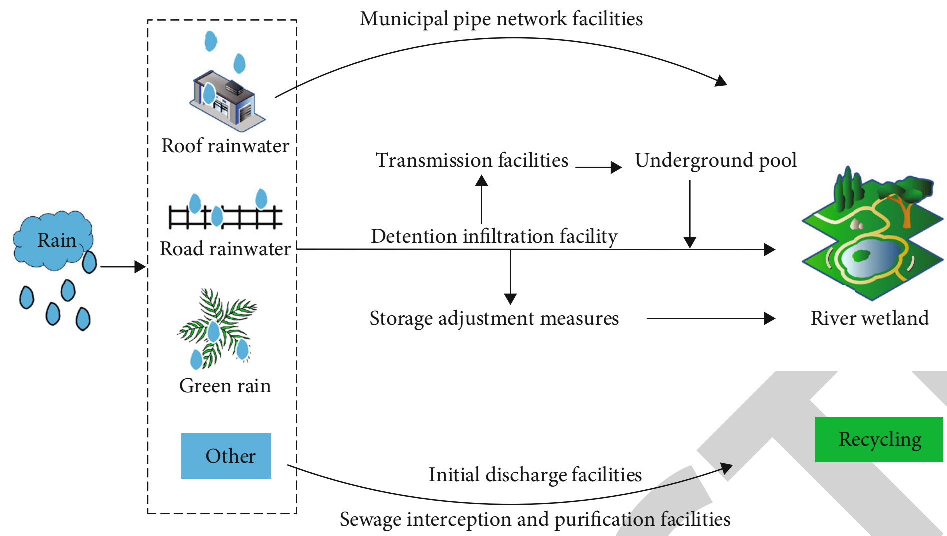

Figure 1: LID concept flow chart.

early warning function and prevention facilities of landscape in disaster prevention; the active and spontaneous resistance to threats; the ability of self-recovery after hazards, and the role of repair to the environment. Increasing the elasticity of the landscape means that in the face of disasters, the loss will be reduced as much as possible, the impact on the natural environment will be reduced as much as possible, and the ecosystem will not be affected as much as possible. This is the improvement of nature's self-protection ability and sustainable development ability.

2.2. Design Method of Green Roof

2.2.1. Load Analysis of Roof Greening Construction. The load of roof greening consists of live load and dead load. The value of live load is a part of the roof design load. It is combined with the dead load of roof structure, thermal insulation layer, leveling layer, waterproof layer, and planting layer, which is the load design value used in the design. Greening or building a garden on the roof is affected and restricted by many factors, and one of the first factors to be considered is whether the roof of the building can bear the load of various engineering facilities of the roof garden, which is directly related to the normal use of the house and the life and property safety of the construction and users. Therefore, before the implementation of roof greening or the design and construction of roof garden, the roof load must be clearly understood. In roof greening design, how to determine the load is an important problem to be solved in structural design.

According to the different forms of roof greening, there are many kinds of plants that can be selected. In addition, the load of each plant is different, so the load value of plants in roof greening can be concluded by experimental method. In addition, when planting large trees on the roof, in addition to the weight of plants and roots, there is also the load of tall planting ponds, which is also an additional and structural concentrated load requiring special checking calculation, which should be paid more attention to in the design. See Table 1 for the basic load of roof greening plants.

Planting soil load is a part of the load in the planting area, and its difference also varies greatly due to different materials. The thickness of planting soil should be determined according to the plant species. The saturated water density of common planting soil shall comply with the provisions in the table below. The saturated water density of common planting soil is shown in Table 2.

2.2.2. Automatic Water-Saving Irrigation System. In order to better realize the automatic water-saving irrigation of roof gardens, it is urgent to accurately predict the water consumption of roof greening, so as to reasonably determine the irrigation system and achieve the purpose of water-saving irrigation. Some scholars tested the actual water consumption by selecting 4 test points with different vegetation, different soil types, different soil thicknesses, different building properties and uses, different water sources, and different irrigation methods. According to the principal component analysis method, they found that: among the factors, the comprehensive index, which is mainly the sunshine time and the relative humidity of the soil, occupies the main position in the influence of the meteorological factors; the second influencing factors are rainfall and temperature. For a roof garden, due to the determination of its geographical location, sunshine time cannot be used as its influencing factor, so this paper selects "soil relative humidity" as an important index to control water-saving irrigation. In addition, due to the problem of high temperature stress found in the experiment, considering the above factors, the paper finally selects soil humidity and temperature as the control factors for automatically opening the water-saving irrigation device. The control layer of the intelligent irrigation system consists of three layers: control center, head control layer, and field control layer. The control center adopts the mode of "decentralized control and centralized management." The head controller in the irrigation system and its

Table 1: Load of different plants.

Plant type	Specifications/m	Average load/kg	Planting load (kg/m^2)
Ground cover plant	$H = 0.5$-0.8	10-20	100-120
Small shrub	$H = 0.5$-1.0	20-40	80-100
Big shrub	$H = 1$-1.5	40-60	80-100
Small tree	$H = 1.8$-2.2	90-110	100-120
Big tree	$H = 2.2$-2.6	110-120	120-130
Fungus plant	$H = 0.3$-0.6	5-10	20-40
Lichen plant	$H = 0.2$-0.4	10-15	30-50
Gymnosperms	$H = 0.1$-0.2	4-8	15-25

Table 2: Saturated water density of common planting soil.

Planting soil type	Saturated water density (kg/m^3)
Pastoral map	1000~1500
Improved soil	700~1200
Inorganic planting soil	400~600
Sandy soil	200~400
Clayey soil	300~350
Loam	200-250

controlled area form a relatively independent intelligent irrigation unit, which can be operated independently. Specifically, based on the above experimental research conclusions, the process of the water-saving irrigation water replenishment system is improved compared with the previous irrigation water replenishment system, changing the control start and stop factors of the original irrigation device. Two detection devices of soil humidity and temperature are used to control the automatic start of the water-saving irrigation system. The automatic monitoring process of the system is as follows (Figure 2).

The water replenishment system is used in the roof garden system. Different from other water-saving irrigation systems, there are two factors controlling the start and stop of irrigation facilities: temperature and soil humidity, which jointly determine the start and stop of automatic water-saving irrigation facilities.

2.2.3. Related Technologies of Automatic Water-Saving Irrigation. The waste of plant water mainly occurs in canal water conveyance, soil water storage and water conservation, and plant transpiration. Collect the information of plants' response to water shortage, carry out precision irrigation according to the law of plant water demand, and develop a series of cutting-edge technologies and key technologies related to water-saving irrigation, such as new water-saving materials and equipment with low temperature and aging resistance required by special environmental parameters. However, considering that the roof garden is built on a narrow building roof, the irrigation method is limited, and only microirrigation technology can be used to realize water management in the later stage. In addition, in order to reduce the water loss in the canal system of the urban roof garden irrigation system, the following irrigation methods are used and improved. Infiltration irrigation is a form of underground microirrigation. This irrigation method uses low-pressure pipeline to deliver water and then through the emitter (microporous infiltration irrigation pipe) buried in the plant root layer to infiltrate water into the soil regularly and quantitatively to supply plants according to the water demand for plant growth. The infiltration irrigation pipe is buried 0.25~0.40 m underground, directly supplies water to the crop roots, and only moistens the underground soil. Under the condition of infiltration irrigation, because the water droplets do not move in the air and do not wet the leaf surface, the ground remains dry after irrigation, and the evaporation intensity of the soil surface is small, so the water directly lost in evaporation is very small. On the other hand, the properly designed and managed infiltration irrigation system can adjust the water supply according to different growth periods of plants without surface runoff and deep leakage, and its utilization rate of irrigation water is the highest (Figure 3).

3. Results

3.1. Comparison of Daily Maximum Temperature of Different Roofs. Due to the difference of surface properties, the temperature of roofs with different covering layers is also different. The temperature of green roof is significantly lower than that of air temperature and cement roof. The average value of the daily maximum temperature of each month is selected as the temperature. June, July, August, and September of each year are the time periods with the highest temperature in the whole year. Taking the temperature of these four months as the research object is representative.

After the greening of green roof and cement roof, due to the different physical properties of green roof and cement roof, the reflectivity of sunlight is also different. In addition, the assimilation and shading of green plants make the net radiation of green roof far less than that of nongreening roof; at the same time, the latent heat consumed by green roofs due to plant transpiration and evaporation is significantly greater than that of nongreen roofs. In this way, the heat

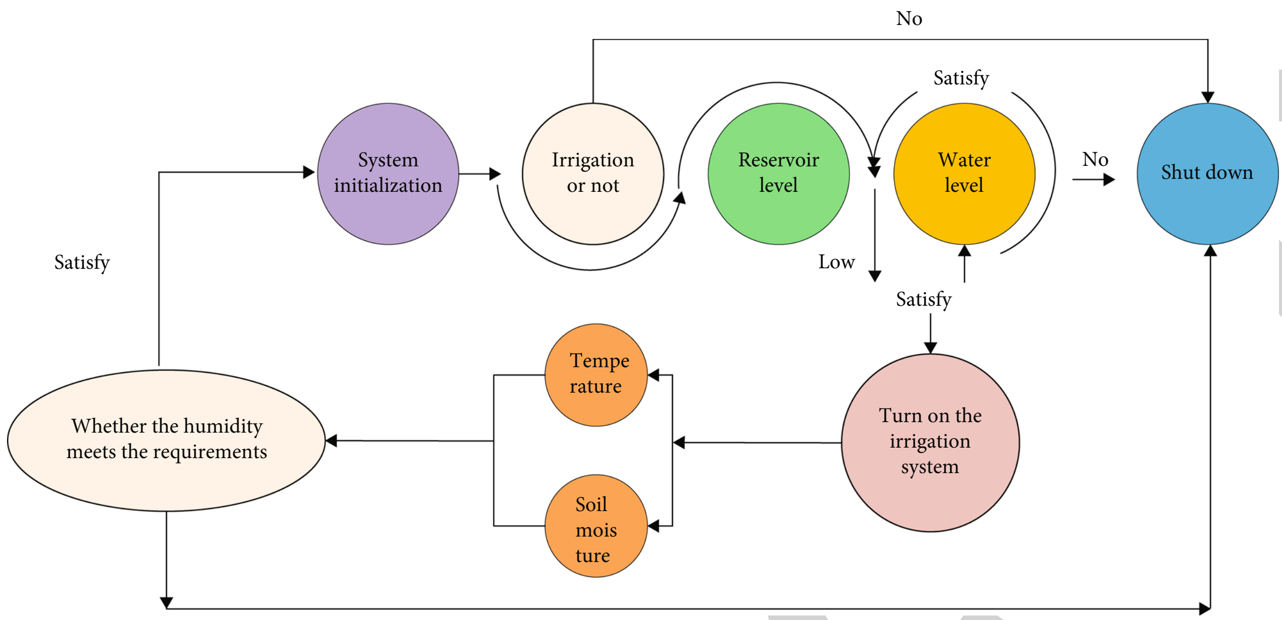

Figure 2: Schematic diagram of automatic infiltration irrigation system for roof garden.

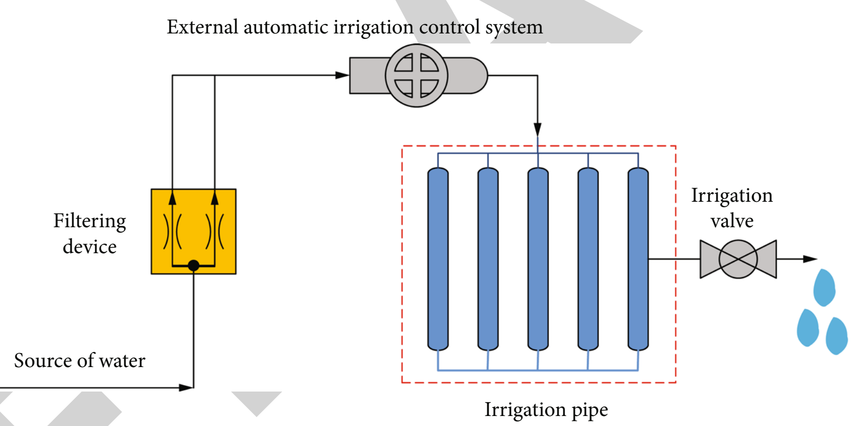

Figure 3: Comparison of daily maximum temperature of different underlying surfaces.

storage of the green roof is greatly reduced, so that the heat obtained by the air of the green roof is less, and the thermal effect is reduced. Therefore, the temperature of the green roof surface is lower than the air temperature, and the cement roof is higher than the air temperature.

3.2. Comparison of Different Roof Surface Temperatures. Figure 4 is the daily variation diagrams of different roof surface temperatures on sunny days in July. The temperature changes regularly with the change of solar radiation, and the temperature of cement roof and green roof also changes with the change of temperature.

At the beginning, the temperatures of the three were in the stage of mild decline to rise. The cooling effect of roof greening is not obvious, and the difference between roof greening and air temperature is about 1°C. After 8 o'clock, the roof greening began to show a good cooling effect. At this time, due to the minimum heat capacity of cement roof, the temperature rise is the fastest. At 14 o'clock, the maximum temperature difference between cement roof and green roof occurs, with a difference of 18°C. Later, with the decrease of temperature, the temperature difference between cement roof and green roof decreased. Comparing the daily average maximum and minimum temperatures of different roof surfaces, it can be seen that house greening plays a good role in regulating the environment. It can be seen that after roof greening, the vegetation coverage has a good regulation effect on the surface temperature, and the temperature change range is small; the temperature of cement roof changes sharply. The daily variation of temperature formed by roof greening is closely related to solar radiation. With the increase of solar radiation, the temperature increases, and the surface temperature of cement roof and green roof increases. However, due to the different heat capacity, the temperature difference of cement roof is the largest, and the change of roof greening is the smallest. After the roof

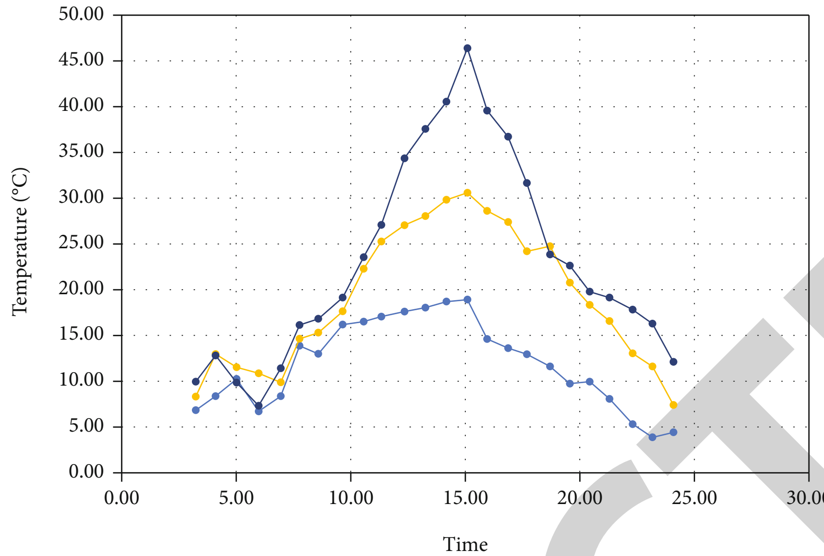

Figure 4: Daily variation diagram of temperature on different medium surfaces.

greening, the temperature curve distribution throughout the day is gentle, maximum temperature difference between day and night 10°C.

3.3. Discussion. Relevant scholars put forward the concept of water sensitive urban design, which is to make full use of rainwater and integrate urban water cycle into urban development [21, 22]. With the concept of ecological civilization gradually rooted in the hearts of the people, the rapid development of urban construction, and the prominent problem of urban waterlogging, scholars pay more and more attention to the theory of sponge city, conduct research from different aspects, and put forward relevant strategies for the design and planning of sponge city in China. The most important feature of sponge city is that it can realize natural accumulation, infiltration, and purification, cross scale water ecological balance, and build a regional urban flood control system to protect the ecological environment and restore the original ecological appearance. Eradicate the urban diseases that perplex people's lives and even endanger the safety of life and property and solve the problems of floods, congestion, and other aspects. It is proposed that in order to build a sponge city, we must reduce the impact on the water circulation system and fully tap the original urban hardware functions such as green space square in the city. The United States is one of the first countries to carry out roof greening in the world. Because of the developed automobile industry, the United States is committed to greening the roofs and squares of underground garages. Roof greening in the United States has set off a "ecological roof movement," which aims to strengthen the research and exploration of ecological roof. The government has adopted various incentive laws and regulations to encourage the construction of ecological roof, which has become a catalyst for the wide application of roof greening. At present, roof greening has been included in the "American green building evaluation system" in the United States. One researcher provides the surface runoff coefficient of different urban land use modes, as shown in Table 3.

Table 3: Surface runoff coefficient of different urban land use models.

Land use mode	Runoff coefficient
Outdoor park	0.1~0.2
Sports ground	0.2~0.3
High-density building	0.8~0.9
Medium-density building	0.7~0.6
Low-density building	0.5~0.6
School building	0.2~0.4
Indoor Park	0.3~0.4
Commercial land	0.2~0.4

Some researchers have confirmed through experiments that green roofs have the functions of delaying surface runoff time, reducing total runoff, extending runoff time, and reducing runoff peaks compared to nongreen roofs, as shown in Figure 5 [23, 24]. However, the roof garden system itself cannot make the surface water leak out, because the upper structure and the lower structure of the building system are closed, and the roof garden allows water to infiltrate or evaporate through the greening system and reform groundwater and natural water [25]. The roof garden greening system has the effect of intercepting and absorbing rainwater falling on it. Rainwater first wets the surface of the plant, then wets the planting soil layer, and is absorbed by the pores of the planting soil layer, and the remaining rainwater is absorbed by the plant and returns to the atmosphere through transpiration [26]. The runoff in Figure 5 is taken from the average value of runoff on rainy days in July.

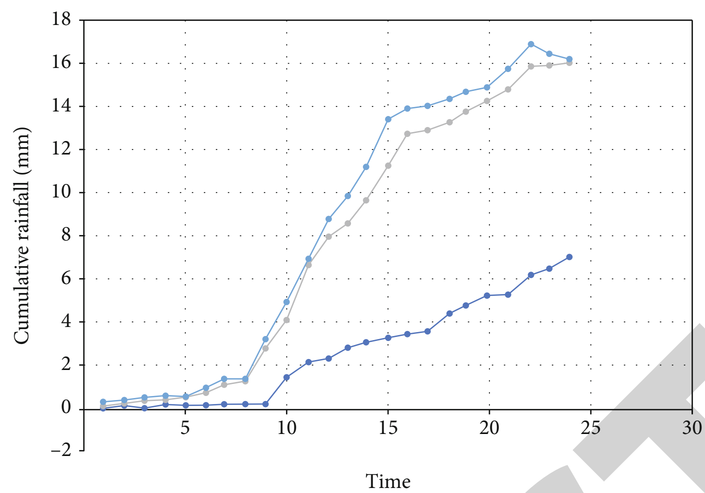

Figure 5: Variation curve of runoff flow with time between green roof and nongreen roof.

4. Conclusions

(1) In recent years, roof garden has developed rapidly under the background of building an energy-saving and environmental protection society because of its unique advantages: intensive use of limited urban space, increasing urban green space area, improving urban ecological environment, and improving building energy-saving effect. Taking the narrow roof garden as the research object, starting from the basic theory of environmental science, and taking experimental research and theoretical analysis as the main research means, this paper studies the cooling effect of roof garden and the improvement effect of urban water environment, obtains the scientific law, and applies it to the design practice of roof garden

(2) By monitoring the temperature changes of atmosphere, green roof, and cement roof in summer, we can understand the daily temperature changes of different materials. The results show that the diurnal variation of roof greening temperature is closely related to solar radiation. With the increase of solar radiation, the temperature rises, and the surface temperature of cement roof and green roof rises. When the temperature reaches the highest value, the temperature difference between cement roof and green roof is the largest, with a difference of 18°C. The green roof has a good function of regulating the temperature. The temperature difference between day and night is 10°C, and the temperature difference between day and night is small. The surface temperature change of the green roof can form a good cooling surface. Therefore, the green roof plays a positive role in regulating the near ground temperature and protecting the building surface

(3) The development trend of roof greening can improve people's living environment. This paper mainly studies the environmental improvement effect of roof garden and puts forward corresponding methods for roof load and preparation irrigation. However, the research mainly focuses on experiments and literature research. Due to the limitations of conditions, no engineering practice has been carried out, and its application effect needs to be tested by engineering application

Data Availability

The figures and tables used to support the findings of this study are included in the article.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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