The Difficulties and Explorations of Old Community Retrofitting Based on the Sponge City Concept - The case of 240 community in the old urban area of Xi'an

Yi Zhao*

Department of Urban Studies and Planning, The University of Sheffield, Sheffield, Britain

* Corresponding Author Email: 201005030130@stu.swmu.edu.cn

Abstract. The rapid development of China's urban modernization has become an important driving force for the flourishing of various economic, social and cultural sectors. At the same time, the process of urbanization has led to the serious phenomenon of "urban diseases", particularly urban water problems. To effectively mitigate the negative impacts of urban floods and droughts, China has proposed a nature-based solution - the sponge city concept. Furthermore, urban renewal initiatives and the Old Urban Renewal Programme (OURP) are vital components in sustainable development to ensure quality urban development and enhance residents' health and well-being.

Keywords: Sponge city, retrofit of old neighborhoods, sustainable development.

1. Introduction

Since China's reform experiment started in the late 1970s, the country has undergone unprecedented economic growth and rapid urbanization and has made remarkable achievements [1]. The gradual extension of the urban framework and the acceleration of the overall growth have resulted in a proliferation of new and denser buildings. However, the crude construction pattern of urbanization and expansion has developed in space, and land use and ground structure in cities have changed. The contradictions and problems of “urban diseases” gradually became apparent. Most notably, the rapid development of urban construction has exacerbated ecological damage and posed obvious risks to human social development. Water issues have become increasingly prominent and have become a major concern for urban development in China. Data indicate that 98 percent of Chinese cities are at risk or susceptible to frequent flooding [2,3]; In addition, a survey conducted between 2008 and 2010 revealed that 218 cities in China had suffered at least one severe urban flooding disaster, of which 137 had suffered three or more [2]. As one of the most common and destructive natural disasters, flooding poses a huge threat to people's lives and property [4], especially in old neighborhoods with weak infrastructure. Therefore, it is imperative to transform and repair old communities that are characterized by early construction, disrepair and neglect, and serious aging of infrastructure.

As a major livelihood project, development project and grass-roots governance project, the retrofitting of old urban neighborhoods has important and positive significance for improving the living environment of the residents, safeguarding the well-being and health of urban residents, and realizing the benign and sustainable development of the society. In July 2020, the General Office of the State Council issued the “Guidelines on Comprehensively Promoting the Renovation of Old Urban Districts”, which put forward clear requirements and guidance on the construction content, financial support, and management mechanism for the high-quality development of districts [5]. Subsequently, nationwide across the country began to comprehensively promote the transformation of old urban neighborhoods and implement urban renewal initiatives [6].

2. The Background to the Retrofitting Development of Old Neighborhoods

2.1. Sponge City's Basic Concept

In response to the negative impacts of growing water problems on the urban environment and society, sustainable stormwater management measures have replaced traditional grey engineering measures. In 2012, the Chinese government introduced the concept of sponge cities as a new urban development paradigm to manage water issues. Unlike the notion of rapid drainage, this new concept aims to guide cities to become “sponges”, utilizing “blue” and “green” urban places in the environment to absorb, store, purify, and reuse rainwater [7]. In detail, the basic architecture of sustainable infrastructure for sponge cities is made up of permeable pavements, green roofs, rain gardens, bioretention, and others.

2.2. Retrofitting of Old Neighborhoods

At present, China's cities have experienced a shift from incremental expansion of spatial resources to stock renewal [8]. In the face of more sustainable urban regeneration development, upgrading older neighborhoods has become an important part of the action to optimize the quality of urban areas. In 2020, to facilitate the renovation of old districts nationwide, the General Office of the State Council issued the "Guidelines on Comprehensively Promoting the Renovation of Old Districts in Cities and Towns", which divides this systematic project into the basic category, the improvement category, and the upgrading category [5]. In terms of refinement, the basic category is to ensure the basic living needs of residents by upgrading public supporting facilities; the improvement category is to meet residents' needs for convenience and improvement of life; Finally, the enhancement category refers to the enrichment of service provision in the community and the surrounding environment to improve residents' quality of life [5]. Accordingly, local governments have successively proposed relevant implementation policies based on local conditions. According to an interview with the Minister of Housing and Urban-Rural Development in 2023, it was highlighted that in the last five years, China has renovated 167,000 old neighborhoods, benefiting 29 million households and more than 80 million residents [9].

In 2015, the Chinese government officially released the “Guiding Opinions on Promoting the Construction of Sponge Cities”, which was deployed nationwide to support sponge city construction [10]. Subsequently, in response to the central government's call, each local government issued specific implementation opinions on promoting the construction of new stormwater management concepts. To solidly push forward the high-quality development of sponge city construction and create a resilient city, the organic renewal of the completed old neighborhoods needs to be integrated with the sponge city concept. It is worth noting that in the “ Implementation Opinions on Promoting Sponge City Construction” issued by Shaanxi Province, it is pointed out that the renewal of old residential areas in old urban areas needs to solve urban waterlogging as a breakthrough, comprehensively promote the overall governance of the region, and gradually realize light rain without water accumulation, the heavy rain does not cause waterlogging, and the heat island is alleviated [11]. Currently, old neighborhood sponge city transformation is being carried out on a large scale in China [12].

3. Practical exploration of the old neighborhood regeneration - the case of the No.240 neighborhood in Lianhu District, Xi’an City, China

3.1. Observation and recording of Yard No.240, Lianhu District, Xi’an City

The Yard No.240 neighborhoods on Lianhu Road is an old community built in 1965 by Shaanxi Sugar, Wine, Fruit and Foodstuffs Company Limited. The entire plot covers an area of approximately 680 square meters. The entire neighborhood has only one remaining residential building, which is

home to 12 families totaling 30 people. In particular, the type of population of the home's residents is dominated by the elderly and low-income groups.

3.2. The main problems existed before the renovation of residential area

The rainwater and sewage pipe network were old, and the infrastructure was weak. Due to the long age of the neighborhood, the residential buildings have been inhabited for a long time resulting in sewerage blockage problems. At the same time, the drainage system of the community existed the phenomenon of mixed rainwater and sewage pipes, untreated domestic sewage was directly discharged into the rainwater pipes, resulting in siltation and poor drainage in the rainwater pipes. Additionally, the overall topography of the residential neighborhood is in a low-lying area, which is below the horizontal height of the surrounding buildings. In the event of heavy precipitation, rainwater from surrounding communities would create a risk of merging and backing up in the Yard No.240. As a result, the neighborhood has long been prone to waterlogging during rainy days, posing a major safety hazard which is a key flood prevention target for the Lianhu District Government.

The second major problem is that the wall on the east side of the corridor in Yard No.240 is in disrepair, with tilts and cracks in the wall. In addition, the road surface of the neighborhood was dirt, which was muddy and potholed, especially on rainy days, causing inconvenience to the neighborhood's residents in traveling. On the other hand, the green coverage of the neighborhood was extremely low, with only two trees distributed in the atrium of the neighborhood's public space and the entrance to the front gate.

In summary, weak infrastructure hurts the safety, health, and well-being of residents. As a result, the residents of the residential block in 2021 relayed their actual plight to the Lian Si community and issued a supervisory order to the property owner through the Lian Si community, which required the infrastructure of Yard No.240 to be rectified and repaired. Aiming at the identified hidden problems, a systematic micro-renovation of the roads, drainage, and walls of Community 240 was carried out on 23 June 2022 with the joint leadership of Shaanxi Sugar, Wine, Fruit and Foodstuffs Co Ltd and Qingnian Road Street Office. On the one hand, the original paved dirt road in Yard No.240 was transformed into a hardened concrete road. On the other hand, the drainage system was reconfigured, eliminating the original mixing pattern and re-establishing separate treatment measures for rainwater and sewage pipes. Finally, the brick wall on the east side of the community was demolished, and concrete was used to restore the whole wall.

3.3. Existing Problems after the Modification of the 240th Community

Due to the low topography of the neighborhood, which has not been properly addressed, the residential neighborhood remains in a low-lying area. The pavement structure in the community is hardened with poured cement concrete. As the traditional building material, impermeability is an important characteristic of the durability of the material. The construction of impervious surfaces prevents infiltration of rainwater and hinders its recharge to groundwater, increasing surface runoff and exacerbating the potential risk of flooding. The limitations of impermeable materials will become increasingly significant due to the low topographical factors of Yard 240; The greening rate within the community is low, with green space accounting for only 1 percent of the total area of the community; In Yard 240, there are still some private buildings and piles of debris as can be seen in figure 1 and figure 2 that occupy public space in the community. In particular, on the east side of the entrance to the building, private dwellings constructed in the form of bricks and mortar are used for residential purposes; The external walls of the buildings in the residential neighborhood are dilapidated and subject to deterioration, with cracks in the facade exposing the internal brick walls, posing a safety hazard to residents as can be seen figure 3; Due to property rights issues, Yard No.240 is not on the government's list of old neighborhoods for renovation, and funding for the community's improvement is the responsibility of its property rights unit, the Shaanxi Sugar, Wine, Fruit and Foodstuffs Company Limited. Therefore, facing a wide range of old neighborhood renovation projects, a single source of funding is one of the most important aspects of the renovation dilemma.

Furthermore, the fundamental difficulties in the governance of old communities also include community residents' low degree of cooperation and motivation.

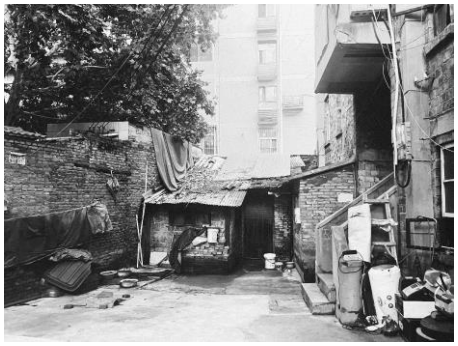


Fig. 1 Private erection on east side of Yard No. 240 (Photo credit: Original)



Fig. 2 Items piled up in front of Yard No.24 residential building (Photo credit: Original)



Fig. 3 Yard No.24 residential building façade (Photo credit: Original)

4. Strategy Research on Sponge City Renewal in Old Communities

4.1. Adaptive characteristics of ecological hardware facilities in Sponge Cities

(1) To address the current concrete floors, the entire subdivision's roadway will be resurfaced, with consideration given to a permeable retrofit of the original roadway and paving upgrades to replace it with colored permeable concrete. As a green and environmentally friendly material, colored pervious concrete has anti-slip properties and is wear resistant. More importantly, this material has high water permeability, and the surface structural layer permeates water quickly as can be seen figure 4. In addition, concerning the roads' color scheme, the aesthetic brick red will be chosen for the renovation.

(2) Increase the area of vegetation in the neighborhood, improve the vegetation cover, and strengthen the ecological protection function. The design will make full use of the vacant public land on the west side of the neighborhood as well as the front and back of the residential buildings for greening. A sunken rain garden consisting of four filtration layers of pebbles, plants, fine sand, and soil will be constructed in the open space in front of the residential building as can be seen figure 5. At the back of the residential building, there will be outdoor wooden flower beds in a small space.

(3) The design will also preserve the existing Tsubaki trees in the yard No.240 by converting them into ecological tree pools and using lawns to mulch the current planting soil layer. Furthermore, a circular outdoor perimeter tree seat will be installed to provide a resting and relaxing area for the residents of the neighborhood.

(4) The fourth aspect is that the roof structure of the residential building is a flat roof and this study will consider creating a green roof on the rooftop of the dwelling. Owing to the loading factors of the residential buildings in yard No.240, the roof will be covered with simple greening. A waterproofing layer will be applied to the roof substrate and a lawn will be laid to effectively absorb and retain rainwater, thus mitigating the effects of flooding.

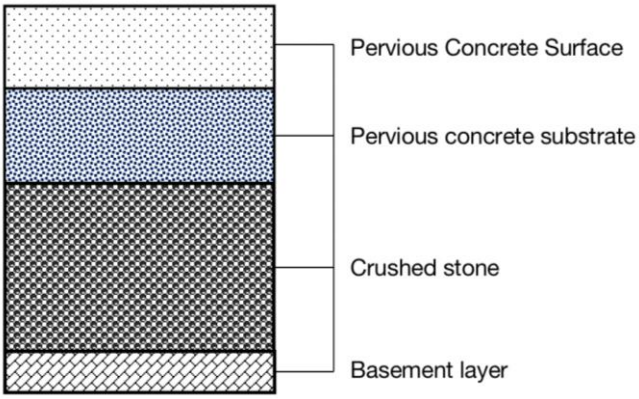


Fig. 4 Permeable structure profile (Picture credit: Original)

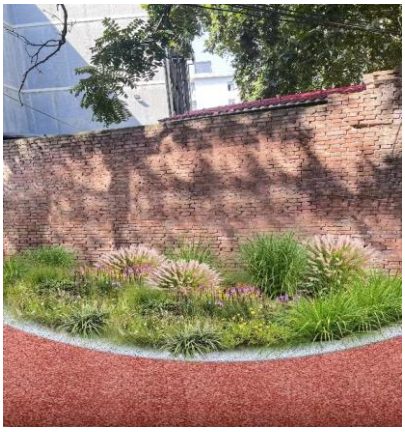


Fig. 5 Rain garden in Yard No.240 (Picture credit: Original)

4.2. Improvement of Infrastructure Upgrading

As the population of the yard No.240 is predominantly elderly, to meet the individual needs of the older people, the aging of the community infrastructure should be improved, including the creation of a fitness area in the northwest corner of the community, with multi-functional fitness facilities. On the other hand, to ensure the safety of the neighborhood and effectively enhance the sense of security and well-being of the residents, illuminated streetlights will be installed in the neighborhood. In addition, the study also recommends repainting the facades of the current residential buildings as well as the interior walls.

4.3. Participatory Creation and Design Co-Construction

This study considers expanding the participation of multiple forces in yard No.240 improvement actions and establishing a sustainable funding allocation model to realize the sponge city concept in the construction and post-operation and maintenance of an old community. In detail, it requires the collaboration of the property owner of the neighborhood, the residents of the neighborhood, and the third party's public welfare funds and charitable organizations. Further, in the process of renovation and daily maintenance, community residents, as an important force, will be encouraged to participate in and supervise the renovation work, to practically improve the needs of the residents and enhance the neighborhood's living conditions.

5. Conclusion

The integration of the sponge city design concept and old district renewal action as a new mode of exploration, the sponge facility's new elements into the old district project construction, is conducive to the realization of the benign hydrological cycle of the old urban area as well as the beautification of the ecological environment of the important role. Based on the sponge city development model, this study systematically analyses the on-site research and basic information of the Yard No. 240 in Lianhu District, Xi'an City, Shaanxi Province, and ultimately proposes a healthy and sustainable renovation design plan for the community's green-grey development project as well as the financial support from three aspects, including the sponge city's basic facilities, the safeguard type of infrastructure construction as well as the mode of social capital participation.

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