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Review on the Current Situation and Shortcoming Remediation Strategies of Urban Excess Rainwater Storage and Drainage System Construction

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Abstract

Under the background of global climate change, extreme rainfall occurs frequently. Coupled with the increase in land hardening rate during urbanization, the problem of urban waterlogging has become increasingly prominent, seriously threatening urban safety and residents' lives. Constructing an efficient urban excess rainwater storage and drainage system is the key to preventing waterlogging and implementing water safety policies, and conducting relevant research has important theoretical and practical significance. Taking the current situation and shortcoming remediation strategies of urban excess rainwater storage and drainage system construction as the research theme, this paper adopts a variety of research methods suitable for review papers to ensure the rigor of the research process and the practicality of the conclusions: through the literature research method, systematically retrieve relevant domestic and foreign journal papers and policy norms, comprehensively sort out the research context and existing deficiencies of urban excess rainwater storage and drainage technologies, shortcoming identification and remediation strategies; use the inductive and deductive method to summarize the core laws of existing research and derive an adaptive research idea combined with the research focus of this paper; use the comparative research method to compare the applicability and limitations of different storage and drainage technologies and shortcoming remediation strategies, and learn from mature research experience; supplemented by the normative analysis method to conform to relevant national and local policy standards, providing compliance support for the research content. The research finds that the current system in China has formed a full-chain technical layout, but there are still prominent shortcomings in multiple dimensions. The targeted remediation strategies proposed in this paper can effectively make up for the construction shortcomings and improve the system operation efficiency. This research can provide practical reference for the scientific construction and efficient operation and maintenance of urban excess rainwater storage and drainage systems in China, and help the construction of resilient cities.

Keywords

Urban Waterlogging; Excessive Rainwater; Storage and Drainage Systems; Current Technological Status; Addressing Shortcomings.

1. Introduction

Under the background of global climate change, extreme rainfall events show a trend of increasing frequency and intensity. In addition, with the continuous advancement of urbanization in China, the land hardening rate has been continuously improved, the rainwater infiltration rate has dropped

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sharply, and the design standard of the traditional drainage system is backward, leading to frequent urban waterlogging disasters, which seriously threaten the safety of people's lives and property and restrict the safe and sustainable development of cities[1]. Constructing a scientific and efficient urban excess rainwater storage and drainage system is a core measure to implement the requirements of the "14th Five-Year Plan for Water Security Guarantee" and the "Implementation Plan for Urban Waterlogging Control", prevent urban waterlogging, and improve urban resilience. Conducting relevant research has important theoretical value and practical guiding significance. As a review paper, this paper focuses on the core of urban excess rainwater storage and drainage system construction and first briefly elaborates on the current situation of system construction: the current system has formed a full-chain technical layout, and various core technologies have gradually matured in practice[2]. However, compared with the advanced international level, there are still problems such as insufficient ecologicalization, low intelligence and poor technical adaptability. The current situation will be elaborated in detail in the main text, then the construction shortcomings will be deeply analyzed, and targeted remediation strategies will be proposed to provide reference for system construction.

2. Current Situation of Urban Excess Rainwater Storage and Drainage System Construction

In line with the requirements of the "14th Five-Year Plan for Water Security Guarantee" and the "Implementation Plan for Urban Waterlogging Control", the current urban excess rainwater storage and drainage system has formed a full-chain technical layout of "source reduction - process storage - terminal discharge". Various technologies are suitable for different urban scenarios, have gradually matured and improved in practice, and have become an important part of the urban flood control and drainage system. Source reduction technologies focus on restoring rainwater infiltration capacity. Permeable pavement, rain gardens, green roofs and other technologies are widely used in urban communities, roads, parks and other areas, effectively reducing the amount of surface runoff and conforming to the concept of sponge city construction; process storage technologies focus on peak flood reduction. Underground storage tanks, river ecological storage and other facilities have become core carriers, taking into account both storage and ecological benefits, and can effectively alleviate the pressure of terminal discharge; terminal discharge technologies focus on safe flood discharge. Facilities such as excess rainwater channels and large drainage pumping stations effectively improve the discharge capacity of extreme rainfall, and work together with source and process technologies to build a comprehensive storage and discharge protection system. At present, the development of urban excess rainwater storage and drainage technology in China relies on policy guidance and pilot practice. On the basis of learning from foreign experience, it has formed a targeted technical route combined with the characteristics of local cities, providing strong support for urban waterlogging control. The specific technical application details and practical effects will be further sorted out in combination with relevant research and cases.

3. Core Shortcomings in the Construction of Urban Excess Rainwater Storage and Drainage Systems

3.1 Prominent Shortcomings in Technology and Standards

At the technical level, the core shortcomings are insufficient adaptability and integration. Some cities lack pertinence in technology selection. Arid cities in northern China blindly promote ecological storage technologies that require large water consumption, and mountainous cities do not arrange hierarchical storage facilities according to the terrain, resulting in poor technical application effects; at the same time, the source, process and terminal technologies lack effective connection, making it difficult to give play to the overall system benefits, and some core intelligent equipment relies on imports, leading to high construction and operation and maintenance costs[3]. At the standard level, a unified full-chain standard system has not yet been formed. The existing norms are scattered, and

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the standards for different regions and technologies are not unified. In addition, the standard update is lagging behind, which is not compatible with the new situation of extreme rainfall and new policy requirements, resulting in uneven construction quality[4,5].

3.2 Prominent Shortcomings in Planning and Operation and Maintenance

At the planning level, the problem of insufficient overall coordination is prominent. The construction of the excess rainwater storage and drainage system has not been incorporated into the overall urban planning and territorial space planning for overall consideration, and is not well connected with the conventional drainage system, urban rivers and lakes, and municipal infrastructure, resulting in unreasonable layout and coverage blind areas; there is a lack of coordination mechanisms between regions, the ability of cross-regional and cross-basin rainwater dispatching is weak, making it difficult to respond to large-scale extreme rainfall, and the planning is not forward-looking enough, failing to fully consider the trend of urbanization and extreme rainfall changes[5,6]. At the operation and maintenance level, the phenomenon of "emphasizing construction and neglecting management" is common. There is a lack of special operation and maintenance teams and fund guarantee, the operation and maintenance technology is backward, and a sound intelligent monitoring and emergency response mechanism has not been established. Some facilities have reduced functions due to silting and damage, failing to play their due role[7,8].

4. Strategies for Remediating Shortcomings in Urban Excess Rainwater Storage and Drainage System Construction

4.1 Strategies for Technology Optimization and Standard Improvement

In terms of technology optimization, strengthen pertinence and integration, formulate differentiated technical routes according to the climate and terrain characteristics of different cities, and promote the coordinated integration of source, process and terminal technologies; increase investment in core technology research and development, promote the localization of intelligent monitoring and precision control equipment, reduce construction and operation and maintenance costs, and strengthen international technical exchanges to learn from foreign experience in ecological construction. In terms of standard improvement, build a unified full-chain standard system, integrate existing scattered norms, clarify unified requirements for technical design, construction, acceptance and other links; strengthen the connection between standards and national policies, transform policy goals into specific standard clauses, and establish a dynamic standard update mechanism to adapt to the development of technology and the new situation of extreme rainfall.

4.2 Strategies for Planning Coordination and Operation and Maintenance Improvement

In terms of planning coordination, incorporate the construction of the excess rainwater storage and drainage system into various overall urban plans, strengthen the connection with conventional drainage, municipal facilities and urban ecological systems, optimize the layout of facilities, and eliminate coverage blind areas; establish a cross-regional and cross-basin collaborative governance mechanism, clarify the responsibilities of each region and department, improve the ability to respond to large-scale extreme rainfall, enhance the forward-looking of planning, scientifically predict waterlogging risks, and avoid redundant construction. In terms of operation and maintenance improvement, change the development concept, increase investment in operation and maintenance funds, set up a professional operation and maintenance team, and carry out skill training; promote the intelligent upgrading of operation and maintenance, build a monitoring and operation and maintenance platform, realize real-time monitoring of facility operation status and rapid handling of faults, improve the operation and maintenance management system and emergency mechanism, and ensure the long-term and stable operation of facilities.

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5. Conclusion

This paper systematically sorts out the current situation, core shortcomings and remediation strategies of urban excess rainwater storage and drainage system construction. The core conclusions are as follows: the current system has formed a full-chain technical layout of "source - process - terminal", and various core technologies have gradually matured in practice, providing strong support for urban waterlogging control, but there is still a certain gap compared with the advanced international level. The system construction faces multiple shortcomings such as imperfect technical standards, insufficient planning coordination and weak operation and maintenance management. These shortcomings are interrelated, restricting the exertion of the system's flood control and drainage efficiency, and there is also a certain gap with the requirements of relevant national policies. In response to the above problems, it is necessary to focus on four key dimensions: technology optimization, standard improvement, planning coordination and operation and maintenance improvement, and formulate differentiated and operable remediation strategies combined with the regional characteristics of different cities to promote the quality and efficiency of system construction. In general, improving the urban excess rainwater storage and drainage system is a core measure to prevent urban waterlogging, implement water security policies and build resilient cities. In the future, it is necessary to continuously strengthen technological innovation and practical application, solve construction shortcomings, and build a solid water security barrier for the safe and sustainable development of cities.

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