# Research on Optimization Paths for Mitigation Strategies of Water Companies in Response to Extreme Droughts

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**Abstract:** This paper discusses the optimization paths of disaster reduction in water companies in the face of extreme drought. This paper analyzes the current situation and constraints in a comprehensive way, and then explains the connotation of improving water use efficiency, ensuring water supply security, and achieving a win–win situation between the economy and the environment are made clear. Further, this paper proposes multi-dimension optimization paths, namely, technological innovation, optimization of resource scheduling, and public participation, and discusses the necessity of government policy support and interdepartmental cooperation. Finally, this paper puts forward the future research direction, that is, the application of new technologies, adjustment of strategies under climate change, localization of foreign experiences, which intend to provide theoretical reference and practical guidance for water companies to establish a scientific, efficient and sustainable drought strategy system.

**Keywords:** Extreme drought; Water company; Disaster reduction strategy; Water resources management

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## Introduction

In recent years, extreme weather events have occurred more and more frequently, and the intensity of droughts has increased, lasting longer, which has a great challenge to global water security. Especially in areas with less water, the influence of drought on water supply systems is more evident, which threatens social security, economic growth and the coordination of the ecological environment. As the main bodies responsible for water supply, water companies should establish scientific and effective disaster reduction mechanism, but most of the current measures have low efficiency and lack of adaptability, lacking systematic optimization and overall arrangement. Therefore, this paper discusses the optimization ways of disaster reduction strategies in drought condition from the perspective of technology, management and policy, and puts forward the future orientation to enhance the adaptability and resilience of disaster reduction strategies in complex climate condition.

## 1 Challenges and status of water companies under the influence of drought

### 1.1 The impact of extreme drought on water resources

The impact of extreme drought on water resources is overall, and is reflected in the depletion of water sources, reduction of water supply amount, and deterioration of water quality. Drought causes a sharp decline of precipitation, and consequently, a sharp decrease of river, lake and groundwater resources during the drought period, which causes the water companies are unable to provide water to the various water consumers in a regular way. Water deficit affects the following fields: irrigation for agriculture, water for industry and domestic water consumption. In addition, the longer-term drought enhances evaporation and increases the risk of water source deterioration. Water source deterioration is more obvious in groundwater, because when the water level decreases, the risk of groundwater contamination increases[1]. Water companies are confronted with two challenges: more extreme water shortage and worse water quality. They should invest more in emergency water supply and protection of water sources, and should also improve the management and allocation of water resources.

### 1.2 Water supply pressure and operation problems faced by water companies

When extreme droughts occur, the water supply problems and operating challenges for water companies are great. First, the depletion of water sources causes water supply interruption. When it comes to droughts, water companies can't rely on usual water sources, they have to invest more in discovering new water sources and strengthening the water supply. Second, the water supply cost for water companies will be greatly raised when droughts happen. It includes the water sources development cost, expanding and maintaining the water transmission networks cost, water quality treatment cost. During droughts, users' demand for water will rise dramatically, water companies will try to balance water conservation and supply, not to extract as much as possible which will bring unsustainable pressure on the ecosystem and make the operating problems more complicated.

### 1.3 Limitations of the current coping strategies of water companies

Although the strategies adopted by water companies to cope with droughts are various, they all have some common deficiencies. Water companies' strategies usually concentrate on enhancing water supply, such as enlarging reservoirs and enhancing water source scheduling. However, these strategies cannot offer basic solutions for long-term drought in the viewpoint of coping with droughts over a long period. In addition, water companies usually do not have proper water-saving strategies and mechanisms to involve users' participation, which results in serious waste of water in some areas and lack of technical guidance to improve water use efficiency. Although policies require companies to invest in new technologies, such as reclaimed water and rainwater harvesting, they also confront many challenges, such as funding, technology and social acceptance. Therefore, water companies should make profound adjustments to their current strategies and seek more efficient ways.

## 2 Optimization objectives and principles of drought mitigation strategies

### 2.1 Improve the efficiency of water resources utilization

Increasing water use efficiency: Combat drought with smart technology.

Improving water use efficiency is an essential part of coping with drought. Water is increasingly scarce and a major challenge for water companies is to get more efficiency out of every drop. Simply boosting water conservation around the house or improving the efficiency of the water treatment process is not the solution[2]. It requires a systematic approach to managing the supply network and a widespread commitment to using smart technologies to provide an accurate and up-to-the-minute picture of usage across all areas so that water volumes and flow rates can be adjusted in real time to prevent either over-supply or under-supply. Encouraging the use of water-saving devices and showing households how to manage their water use efficiently is also important, especially when extreme droughts put a strain on the water supply.

### 2.2 To ensure the long-term stability of water supply

The long-term stability of water supply is of great concern to the water companies when encountering extreme droughts. Long-term stable water supply not only depends on the sustainable water resources, but also needs the water companies to build up and perfect the source protection, scheduling and management system. Water companies should guarantee the water supply from multiple sources during droughts, enhance the diversity and flexibility of water sources. For example, strengthen the rainwater harvesting, wastewater reuse, groundwater recharge, so as to reduce the dependence on a single source and avoid the water supply interruption caused by a single source depletion. Establishing a complete water resource monitoring and early warning system can discover water problems at the initial stage and make timely adjustments to guarantee the water supply stability and sustainability.

### 2.3 Achieve a balance between economic benefits and environmental protection

Drought mitigation should not be limited to the economic benefits of water companies. In addition to the economic benefits, what water companies also need to focus on is environmental protection. Over-exploitation of water resources to satisfy the needs of human beings in the short term may cause environmental problems in the long term, such as ecological imbalance and land desertification. Therefore, water companies should take water resources sustainability into full consideration and optimize the water use to avoid over-extraction[3]. On the other hand, water companies should

adopt green technology and low carbon measures to reduce energy consumption and pollutant emissions so as to achieve the goal of environmental protection in water treatment and distribution. Only by technological innovation and policy guidance can water companies explore the best way to coordinate water conservation, energy saving and the environment and promote the green and sustainable development.

## 3 Optimal path of disaster reduction strategy for water companies

### 3.1 Technological innovation and intelligent management

Technology innovation is an important way to solve the problem of extreme drought, and water companies should strengthen investment in intelligent management. By introducing advanced technologies such as the Internet of Things, big data and artificial intelligence, water companies can realize the real-time monitoring and analysis of water sources, pipelines and water use, and then realize accurate water supply and optimized allocation. For example, smart water meters and sensors can automatically collect user water usage data, and then analyze the data to predict the peak period of water use and adjust the amount of water to be supplied in advance to avoid wasting water resources and insufficient water supply. At the same time, the automatic control system can effectively reduce the manual operation error and improve the efficiency of water treatment and distribution. Through technological innovation, water companies can not only improve operational efficiency, but also better respond to sudden water source shortage situations caused by droughts, ensure stable water supply and continuous water supply. With the continuous development of intelligent technology, water companies can also use technological empowerment to realize fine management of water supply networks and green sustainable development, and provide more powerful support for coping with extreme droughts.

### 3.2 Optimize the allocation and scheduling mechanism of water resources

Rational allocation and scheduling is the key strategy that water companies should adopt to cope with drought. When the water resources are deficient, in addition to the fair water supply, a reasonable allocation of water resources can effectively avoid over-exploitation or over-use of water in some areas. Water companies should base on the construction of water resource management system to rationally plan the source water distribution and accurately schedule the water supply capacity of different water bodies. For example, during droughts, the domestic water use and water use of key industries should be guaranteed first, and the peak-hour water supply pressure can be relieved by time-slot scheduling. In addition, more use should be made of groundwater, reclaimed water, rainwater, and the proportion of unconventional water resources should be increased. Only by rationally scheduling the water sources and optimizing the allocation of water resources, the pressure caused by drought can be alleviated, and it also gives water companies more flexible countermeasures, reduces the risk of water shortage. The water companies should give full attention to improving the ability of resource scheduling and optimizing the water supply model.

### 3.3 Strengthen water-saving publicity and user participation

Water conservation popularization, and the participation of users are the key links in the water companies" disaster reduction plan. Water companies should do a good job in popularizing water conservation knowledge, enhance residents and enterprises' water conservation awareness, encourage users to participate in water conservation. Water companies can make full use of mass media and channels to popularize water saving knowledge and encourage users to participate in water saving through online education, community activities, etc., so that users' environmental awareness and water saving awareness can be enhanced, and they can use more water-saving equipment and technologies in their daily life, thus reducing unnecessary water consumption. In addition to users' participation in water conservation popularization, water conservation pricing and incentive mechanism should also be reflected[4]. For example, dynamic pricing and tiered water prices should also be used to guide users to use water reasonably. In the dry season, water companies should implement corresponding water usage restrictions according to the degree of water shortage. Through the social participation mechanism, water companies should make the public understand and participate, so that all water-saving measures can be implemented smoothly.

# 4 Improving policy support and regulatory mechanisms

## 4.1 Formulation and implementation of government support policies

The support of the government in water companies' drought reduction strategy. In view of the extreme droughts, the government should make and implement some policies and offer more funds and technology support to encourage water companies to invest more in the construction of water facilities, technology innovation and water resources management. Especially in the areas with frequent droughts, the government should encourage water companies to invest more in water-saving technology and water treatment facilities with subsidies and tax preferences so as to enhance the water utilization. Meanwhile, the government should further strengthen unified planning and scheduling of water resources, improve more detailed water resource management policies and reasonably allocate water resources. Only through the drought reduction strategy and the government's active support can water companies get more resources and water, which will enhance the ability to resist drought and reduce the impact of water shortage on society and the economy.

## 4.2 The soundness of the regulatory system and the intensity of its implementation

A sound system of regulations and strict enforcement are the keys to compelling water companies to implement disaster reduction plans. There are some regulatory blank spots in the water resources' supervision field. The supervision of some water companies' water source occupation and pollution control in certain areas is still lacking enough supervision and inspection, which causes serious waste of water and environmental damage. The government should improve the regulatory bodies' functions in order to reasonably allocate and use our country's water resources. In addition, the government should inspect the water companies' implementation of disaster reduction plans regularly and find out whether their operation violates the national environmental protection and water conservation regulations or not. By establishing the water resources regulation system, the government can strengthen the supervision over the water companies and urge them to improve the technology and management level continuously so as to enhance their ability to resist droughts.

## 4.3 Cross-departmental collaboration and social participation

Addressing extreme drought requires cross-departmental collaboration and broad participation from all sectors of society. Water resource management involves multiple departments, such as environmental protection, agriculture, industry, and urban construction. Efforts by a single department are insufficient to tackle the complex issues of water resource management. Therefore, the government should promote cooperation among various departments, establish coordination mechanisms, and jointly research and address the water scarcity caused by drought. Additionally, the public, businesses, and non-governmental organizations should actively participate in the protection and management of water resources[5]. By enhancing public awareness of water resource protection, supporting public participation in water-saving actions, and promoting green technologies, we can form a collective effort to combat drought and improve the effectiveness of disaster reduction strategies for water companies. Cross-departmental collaboration and extensive social involvement can facilitate the rational use of resources, provide more support and guarantees for water companies, and promote sustainable water resource development.

# 5 Future research direction and development prospects

## 5.1 The application prospect of emerging technologies in drought response

With the development of technology, drought response emerging technologies are constantly emerging. For example, intelligent water management technology and big data analysis can realize fine monitoring and forecasting of water resources and respond to drought risks in a timely manner; water companies can allocate water resources more reasonably by using artificial intelligence and machine learning technology to analyze factors affecting water resources such as water demand and climate change through algorithms, so as to improve the utilization rate of water resources and avoid waste. Meanwhile, emerging technologies such as desalination, collection of rainwater and reuse of wastewater are gradually maturing and becoming reliable water sources for water companies in extreme droughts. In addition, low carbon

green technology has further reduced energy consumption in the process of water treatment and transportation, promoting the sustainable development of water resources. The application prospects of emerging technologies can not only improve drought response capabilities, but also promote innovation and development of the water industry in the face of severe global water crisis.

### 5.2 Adjustment of water resources management strategies under climate change

The effect of weather change on water assets must be recognized, significantly in drought-prone areas the availability and distribution of water resources are indeterminate. In the presence of problems induced by weather change, water resources management methods should be adjusted. Firstly, water companies should forecast future weather change in a whole system and clarify the possible impacts on water sources as well as take corresponding measures for water resources according to the forecast. Secondly, more comprehensive management and cross-regional coordination of water resources should be conducted to prevent the lack and waste of water resources during the scheduling and allocation of water resources under the condition of change of climate. Besides, more flexible water management policies should be encouraged. For example, flexible pricing and restrictions on water supply should be adopted to cope with the impacts of climatechange. Most importantly, emergency response plans should be established by water companies to deal with the extreme weather as soon as possible, so as to reduce the impact of climate change on water resources and guarantee the continuous water supply to residents and industrial enterprises.

### 5.3 The combination of international experience and localized coping mode

International experience can offer references for coping with droughts, however, climate conditions, socio-economic conditions and water resource conditions in two regions may be quite different. Therefore, constructing local response models is very important. Absorbing advanced international experiences and taking local conditions into consideration, water companies can construct more appropriate drought response models according to their own characteristics. For example, Australia and Israel have made remarkable progress in managing water resources in arid areas, with advanced water-saving technologies and water use strategies providing references for other regions. However, when referring to international experiences, localization should also be considered based on water endowment, level of infrastructure and social acceptance. Through scientific policy making and technical services, combining international experience and local conditions may provide more appropriate and sustainable solutions for extreme droughts and enhance the ability of water companies in drought periods.

## 6 Conclusion

This article thoroughly discusses the operational difficulties of water utilities during extreme droughts and the inadequacies of current approaches, and then clearly defines the three objectives for improving the disaster reduction strategy and forms an optimization path for water disaster reduction from four aspects: technology, quantity, people and policy. The results indicate that the improvement of intelligent level of water resources management, awakening public awareness of water saving and intergovernmental cooperation are the basic ways to enhance drought resistance. In addition, advanced technologies should be introduced, adapting to the trend of climate change and localizing the advanced experiences of other countries. Through the diversified cooperation and innovation of mechanisms, the water utilities can cope with drought risk and establish a stable, efficient and sustainable water resource management system.

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