水务企业在中国城市韧性水环境系统构建中的角色与责任

ENTERPRISES' ROLE AND RESPONSIBILITY IN CONSTRUCTION OF RESILIENT URBAN WATER SYSTEMS IN CHINESE CITIES

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摘要

本文以北控水务近年来参与并领导的一系列城市水生态环境治理课题研究，水治理领域从研究到应用的技术转化，目前中国各个地区水环境治理现状、重心和存在的问题，以及如何转变公众对于城市中灰色水务设施的认识并加强公众参与为切入点，针对水务企业在中国城市水环境韧性构建中的角色与责任进行了探讨。受访人冒建华指出，中国幅员辽阔，地域发展非常不平衡，不同地域的诉求也不尽相同，水环境问题往往复合了产业结构、基础设施、社会管理等多重因素，并强调灰色基础设施是水环境治理成功的基础，生态基础设施则发挥着提高与升华的作用；他同时认为，提升中国城市水环境的韧性和可持续性还有赖于广泛的公众参与和全社会的共同构建。

关键词

城市水生态环境；技术；灰色基础设施；公共参与；韧性；可持续性

ABSTRACT

This article focuses on enterprises' role and responsibility in improving urban resilience of water environment of Chinese cities, starting with the research efforts of Beijing Enterprises Water Group in recent years, the application of water pollution remediation technologies, then to the current status, key tasks, and problems in China's water environmental remediation, as well as how to change people's awareness of grey water facilities and infrastructures and promote public engagement. Mao Jianhua, the interviewee, argues that it is important to understand that the regional situations vary in China, water environmental problems are complicated resultants of industrial structure, infrastructure construction, and social management; to deal with China's water environmental issues, we shall develop phased roadmaps combining with social-economic development. He believes that a working water environmental remediation is guaranteed by grey infrastructures and is facilitated or improved by ecological infrastructures. He also emphasizes that public engagement plays a decisive role in improving the resilience and sustainability of urban water environment.

KEY WORDS

Urban Water Environment; Technology; Grey Infrastructure; Public Engagement; Resilience; Sustainability

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我们了解到近年来北控水务参与并领导了许多城市水生态环境治理的课题研究，能否向我们简要介绍一下？

冒建华（以下简称冒）：目前，北控水务的科研课题主要包括两大类：一类是国家课题，例如十三五水专项“北京城市副中心高品质水生态建设综合示范项目”中主持和参与的几个课题，即是以北京城市副中心（通州）为研究对象，探索如何构建一个具备高连通性、高开放性的，拥有蓝绿交织体系的城市生态空间。当前，中国少有由水生态环境治理企业主持的国家级研究课题，一般仅为参与；北控水务希望更多地参与到前沿性研究当中，率先进行企业转型与探索。

另一类是北控水务的自主立项研究课题，以支撑企业发展战略，以解决实际应用中的技术问题为主要方向，每年会有2 000万元左右的经费投入。

这些研究的输出成果主要有三种形式：

1）理论技术。以十三五水专项“城区景观河流水系连通与北方地区典型黑臭河道治理关键技术研究与示范”课题为例，其研究成果会形成一套规范的技术指南体系，该体系既能对水系治理过程中一些普遍问题进行指导，还可为雄安等新城建设提供借鉴。

2）示范性工程。通过北控水务中标的实际工程，将一些技术成果以实践的方式展示出来，打破以往课题研究多限于理论总结的局面。

3）智慧管控平台。我们希望能够将从规

范标准到实际建设和运营数据转化的整个过程集成于一个信息化管控平台之中，实现大数据应用管理、使用者智能感知以及与智慧城市的对接等。

除课题研究外，北控水务还相继成立了水环境研究院、北控水务院士专家工作站、未来城市研究平台等研究机构。这一系列学术研发平台的构建有着怎样的目的？

冒：这一系列学术研究平台的构建行动是以北控水务“双平台战略”为基础的，即同时建立轻资产平台和运营平台。目的是将北控水务的投资能力、技术能力和运营能力进行示范性整体展示。“双平台战略”的核心在于领先的技术能力。自2016年起，我们开始整合投资及技术体系，着力培养具备技术与投资综合能力的团队，只有投资、技术与人才三者并重，才能持续推进水环境相关业务的发展。

我们希望将院校和研究机构的科研成果应用到实践项目中，真正打通产学研的通道，这同时也满足了共赢的合作需求。然而，目前中国水环境治理领域内的此类通道尚未被完全打通。究其原因，一是参与的企业太少；二是科研机构的课题立项与企业需求之间往往存在差异，很多研究成果只能被束之高阁；三是研究人员普遍缺乏研究成果产业化转化的途径，我个人认为产业化的核心推动力之一在于资本的加入，无论是传统行业还是互联网等新兴行业，起步时期往往都需要借助资本加速其发展；四是研究人员个人抗风险能力低，要想在真正意义上实现技术的产业化转化非常困难。创新、创业失败的可能性非常大，你不能让研究员拿着自己的身家去搞项目。因此，北控水务提出做一个“科技弹射器”的理念，在对研究成果进行技术研判和前景展望的基础上，提供一个成果转化的平台，从资金到技术应用再到企业管理全面支持个人和小微企业创新、创业。

您如何评价目前中国的水环境治理现状？

冒：中国幅员辽阔，地域发展非常不平衡，而且不同地域的诉求也不尽相同。华南地区是国家水污染考核的重点区域，这些地区项目的限定因素往往不是资金，而是如何在保持现有经济发展的基础上解决突出的黑臭水体问题，让水环境治理的投入更有效，因而水环境治理项目绩效达标是华南地区项目的“刚需”。

华东地区（包括上海、江苏和浙江等地）水环境治理的重点已不再是黑臭水体治理，而是消除劣Ⅴ类水体。以江浙地区的太湖蓝藻治理为例，它已经从简单的治理技术问题演变为涉及区域产业结构调整、社会引导管理、生态环境管理等诸多领域的复合问题。而长江经济带等跨省市资源管理区域则需要协同保护与发展，考虑“绿水青山”如何变为“金山银山”。

华北地区（主要为京津冀地区）目前依然是以消除黑臭水体为主，尤其是在雄安新区建设的推动之下，河北省面对的主要是来自政绩、财政、技术等多方面的压力。

综合来看，在水环境治理的问题上，一方面要重视水环境治理的阶段性，适应社会经济发展节奏；另一方面还要重视水环境治理的系统性，因为水环境问题往往复合了产业结构、基础设施、社会管理等多重因素。

您认为当前水环境生态治理的技术应用领域中存在哪些问题？

冒：首先，我们需要认识到，中国的水环境生态治理问题具有特殊性，世界上从来没有哪个国家存在像中国这么严重的黑臭水体问题。极大的人口和产能规模带来了巨大的污染负荷，同时不平衡的发展状况和资源分布也让中国不同区域的水环境问题各有差异，在这个前提下水环境治理技术往往都存在局限，因此针对性的研究与技术集成应用成为了水环境治理成功的关键。

其次，在水环境治理中存在两个误区：一是认为污水处理厂提升水质处理标准后，水环境质量就能达标；二是生态基础设施的净化能力被片面夸大。整体上来看，城市环境发展水平的下限是由灰色基础设施决定的，而上限是由生态基础设施决定的。灰色基础设施是水环境治理成功的基础，生态基础设施则发挥着提高与升华的作用。当水体污染浓度较低时，植物或微生物的净化功能或许能够解决水体污染问题；而当水体污染浓度很高时，植物或微生物自身的存活都是个问题，还能指望它们起到净化作用吗？生态系统不是用来“消减污染”的，而是用来充当缓冲和发挥调节功能的，因此应在水体得到一定的净化后，再让生态系统来发挥作用。而且，只有当污染治理到一定程度时，生态景观的作用才能突显——这也是欧洲、日本等国家和地区的生态环境更好，或者他们管理得更好的原因。并不是因为这些国家建了某些湿地公园，环境就变好了；而是因为他们的灰色基础设施比中国完备得多，而且对于居民的环境教育普及也更到位。

再次，应用市场缺乏对于技术的必要判断能力。现在市场上有成百上千种新兴的水环境治理技术，其中不乏一些优秀的技术，但同时存在大量片面夸大效果或者对应用环境界定不清的情况，这不但不利于推动技术发展，反而会造成业内对这类技术的不当应用，甚至造成资源浪费。

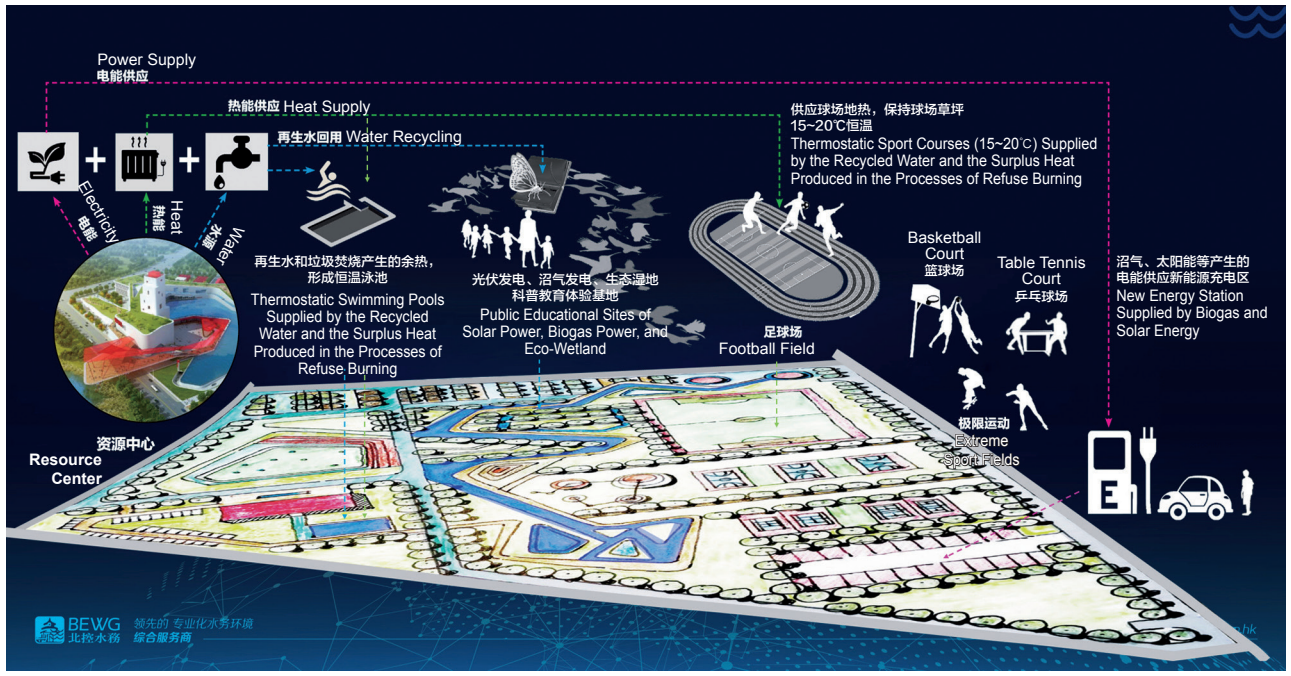
当前，公众对自来水厂、污水处理厂等灰色的“城市生命基础设施”普遍存在误解，认为灰色的就是不生态的。北控水务在消除这种公众认知方面做出了哪些努力？

冒：打个比方，一座城市中的灰色基础设施就像人体的各个器官，我们可以把自来水厂比作心脏，负责给全身供血；污水处理厂比作肾脏，负责处理污水；如果把管网比作血管，那么自来水管是动脉，雨污管则是静脉。

但是，为什么老百姓会将这些灰色基础设施等同于不生态呢？第一，目前灰色基础设施从材料到建设过程往往给人不生态的印象，比如：污水处理厂、污泥处理厂等由于气味等因素造成对周边环境的影响；这个问题可以通过改造除臭设施或改建地下处理厂来解决。第二，起初，这些基础设施的选址离城市并不近，但是随着城市的快速扩张被逐渐纳入城市建设范围内，也就不可避免地对我们的生活造成了干扰。针对这个问题，目前我们正在努力尝试改变这些设施的运行模式，在条件允许的情况下，将这些设施向公众开放。比如，北控水务提出“ECOPARK+水厂”的理念，将这些设施向社会开放，让环保设施与社会相互拥抱。

在面向公众的宣传教育中，我们不会一味强调“五污合一”这类生涩枯燥的技术术语，而是通过营造生活场景让公众体验环保设施。比如，我们希望市民可以了解到，地下污水处理设施不仅几乎不会对周边社区带来消极影响，还可以对垃圾、污泥等进行协同处理，形成能源供给系统，利用余热、余电营造高品质地暖球场、新能源汽车充电场等环保设施；利用污水处理净化后的部分新生水可建造恒温泳池；利用部分地上空间可建设城市“P+R停车场（无缝驳接停车场）”，并结合地上景观，设计可供市民参观的环保教育游线，使大家直观地了解这些设施在提升城市水环境的韧性和可持续性方面的意义。

再者，水环境治理与保护的基础还有赖于广泛的公众参与。目前，在中国，水环境治理的费用远远超过环境保护教育的投入。在广东的一个项目中，我们正在尝试将部分运营费用专门用来奖励沿线居民的良好生活习惯的养成，鼓励大家进行河道垃圾清理和污染行为监督；同时建立当地的环保志愿者组织，并从运营经费上予以支持。试想，如果大家都直接往河道里扔垃圾、倒污水，那即便花十倍的钱来治理也未必能解决问题。通过这些公众参与的手段，使水务设施成为市民日常生活当中的场景元素，能够为人所见、所用，大家自然也就乐于接受了。**LAF**



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1. 通过场景体验的形式，使水务设施成为市民日常生活当中的一部分，能够为人所见、所用。

1. Scenarios: Through diverse experiencing programs, water facilities are integrated into people's daily life.

We learn that, in recent years, Beijing Enterprises Water Group (BEWG) has taken part in and led many research projects on urban water environmental remediation. Could you please make a brief introduction?

MAO Jianhua (MAO hereafter): At present, BEWG's research can be categorized into two levels: state-supported projects and independent projects. BEWG has engaged in several state-supported projects, such as the Demonstration Project of High Quality Water-Environmental Construction of Tongzhou Sub-Center in Beijing, part of the Special Research Project of 13th-Five-Year-Plan on Water Environmental Issues, in which BEWG led a series of research to explore how to build a blue-green eco-city with high connectivity, openness, and liveability. Currently, in China, although there are quite a few water eco-environmental remediation companies who have participated in state-supported research projects, only few of them play a leading role. BEWG would like to contribute to more national frontier studies, advancing such explorations.

In the independent projects launched by BEWG itself, we address application-related technical problems to offer intelligence support to BEWG's long-term strategic development. The research budget is around RMB 20 million annually.

The results of these research mainly include:

1) Technological study reports or handbooks. For example, in the Research and Demonstration Project of Key Technologies for Improvement of the Connectivity of Urban River Systems and Malodorous-Black River Remediation in Northern China, part of the Special Research Project of 13th-Five-Year-Plan on Water Environmental Issues, we compiled and issued a series of technical specifications and guidelines, not only offering solutions to many common problems in water-environmental remediation practices, but also inspiring the urban construction of new towns like Xiong'an.

2) Demonstration projects. BEWG applies its technical achievements into real projects, for both demonstration and performance-test purposes, which would in turn inform our research and practice.

3) A smart integration platform. With a hope to bridge research results with reality applications and to collect data both of specification development and actual construction and operation, BEWG aims to build an information-based platform that uses big data management to provide intelligent services for citizens and to help build smart cities.

It is prominent that BEWG has made its efforts on academic collaborations with China's leading colleges and institutes, such as the establishments of BEWG Water Environment Institute, BEWG Academician Workstation, and the Future City Research Center. Would you please introduce the backgrounds and purposes of such collaborative actions?

MAO: These academic collaborations are part of BEWG's Twin-Platform Strategy — establishing a light-assets platform and an advanced operational platform, aiming to display and integrate BEWG's overall capacities in investment, technology, and operation. The core of this strategy is to hold leading and advanced technologies. Since 2016, BEWG has begun to integrate investment and technological systems and given its priority to talent training. We believe that investment, technology, and talents are three integral parts in continuously enhancing our strengths in water environmental remediation.

There is a mutual desire of research institutes (including colleges) and water-environmental remediation enterprises to bridge research efforts with practical applications. However, at present, breakthroughs of such collaborations are rarely seen. The reason lies in four aspects: 1) few enterprises make their substantive efforts in collaborative explorations, or have limited access; 2) much research stays in a high-hypothetical status, or fails to offer significance to reality practice; 3) researchers are often not capable of or lack access to propelling their research achievements into industrialized or commercialized technological products. But capital does — in my opinion, capital acts as the core impetus to the promotion of technologies, be it traditional industry or emerging business; and 4) most researchers, in reality, would not endure the risk in the industrialized process — You cannot ask researchers to risk their

all money, time, or energy on one single project because the failure possibility is quite high when you kicked off a new business. Thus, BEGW sees itself as a "catapult" of technological innovation: by evaluating the performance and prospects of certain technological achievements, BEGW would provide necessary help and support for researchers, investors, and practitioners, and other stakeholders to help succeed a full-process application and implementation.

How do you consider the current situation of water environmental remediation in China?

MAO: Regional situations vary in China. South China is one of the most developed regions of the country but suffers from the worst water pollution problems. Most malodorous-black pollution remediation projects are well funded while facing rigorous performance evaluation challenges: the remediation must be efficient and effective and would not encumber local economic or social development.

Beside of the malodorous-black pollution problem, East China, including Shanghai, Jiangsu, and Zhejiang, faces a more tricky challenge in water environmental treatment: most remediation projects in this region are developed to improve water quality and urban living environments. Taking the Taihu case as an example, the lake site has suffered from a severe algae bloom problem in history, and the remediation plan has to respond to complicated issues from industrial restructure, public engagement to ecological security management. Meanwhile, for the cross-province resource management areas, such as the Yangtze River Economic Belt, collaborative protection and development are encouraged in order to realize a best use of natural resources and maximize landscape and ecological values.

To the cities in North China, covering Beijing, Tianjin, and Hebei, currently, malodorous-black pollution is still a major water problem to deal with. Besides, Hebei Province is also facing huge political, financial, and technological challenges, especially under a larger background of the construction of national new towns like Xiong'an.

To deal with China's water environmental issues, on a whole, we shall develop phased roadmaps combining with social-economic development. It is also important to understand that water environmental problems are complicated resultants of industrial structure, infrastructure construction, and social management, which require more comprehensively planned solutions.

What problems do you think are there in the current application of water environmental remediation technology?

MAO: First of all, we need to recognize that China's water environmental problems are unique, for example, China is suffering from an unprecedented malodorous-black pollution problem in the world's history. China accommodates the largest population and has the most production throughput around the world, which have brought an extremely high polluting load to the country. Meanwhile, due to the varied natural and physical settings, development levels, resource conditions , and other related limitations of different regions, more specific, integrated technical solutions are required to address China's water environmental issues.

Secondly, now there are two misunderstandings in the water environmental treatment: first, the overall water environment cannot be improved merely by relying on a high-standard purification of water quality by wastewater treatment plants; second, an ecological infrastructure's purification capacity is often exaggerated. Generally speaking, the urban development and the basic functions a city performs are supported by its engineered (grey) infrastructures, while how diverse or vibrant or robust a city's ecological, social, cultural, and other services could be is determined by its ecological (green) infrastructures. In other words, a working water environmental remediation is guaranteed by grey infrastructures and is facilitated or improved by ecological infrastructures. To the cases of a low water pollution concentration, ecosystems could purify water quality through plant adsorption or microorganisms; but when the water pollution concentration is very high, plants or microorganisms would no longer survive, let alone to solve pollution problems. Instead of reducing pollutants, the main ecological function of natural

or constructed ecosystems is to act as resilient buffers that mitigate impacts and regulate services. Only when the pollution concentration lowers to a certain level, an ecosystem could play its role in water purification — through a series of case studies on the urban eco-environmental construction in Europe, Japan, and other developed countries and regions, we found that an overall environmental improvement of a city can be only realized with a sophisticated grey infrastructure system, a well-designed green infrastructure network, and a public environmental education, rather than building several eco-parks or urban wetlands.

Thirdly, at present, a requisite assessment criterion on the application of technologies lacks in China. Right now there might be hundreds of new water treatment technologies and some of them work indeed. But, quite often, the efficacy and application scope are overstated or unidentified, which contributes nothing to technological development, but would cause improper application or even a waste of resources.

Water plants, wastewater treatment plants, and other urban water utilities are vital to a city's functioning. However, at present, such engineered infrastructures are often misunderstood as an opposite to ecological construction. What efforts has BEGW made to change people's awareness of grey infrastructures?

MAO: Grey infrastructures of a city are like the organs of a human body: water plants as heart that works for water supply; water treatment plants as kidney that works for sewage treatment; and water pipe network as vessels that work for water circulation — water pipes as arteries and drainage pipes as veins.

In my opinion, the reasons why the public often equate these vital grey infrastructures with non-ecological construction are found in two aspects: First, most water utilities and infrastructures are built on the ground which might emit unpleasant smells or cause visual impact to surrounding neighborhoods. This problem can be solved by improving deodorization facilities or building underground infrastructures. Secondly, the locations of most urban water infrastructures were initially far from built-up areas; but, as city sprawls, more and more infrastructures have been wrapped with urban development and become part of the urban fabric of cities. As a response, BEGW has made efforts in changing public awareness of such "grey" infrastructures by promoting an integration of water utilities into citizens' daily life. For example, we put forward an initiative of "EcoPark + Water Plant" that aims at opening these facilities to the society to increase public recognition and engagement.

In public educational programs, we would not intent to explain the technical terms like "integrated sewage treatment system," but disseminate water environmental knowledge through various experiencing activities. For example, combing with site visits and interpretation systems, citizens are expected to understand that underground sewage treatment facilities not only have little impact on their living environment, but also help reduce urban energy consumption by recycling the surplus heat and electricity collected in the process of sludge or refuse burning for various aboveground amenities and facilities, such as ground-heating stadiums, vehicle charging fields, thermostatic swimming pools, and P + R (Park + Ride) lots. Besides, combining with landscape design, interpretive trails can be created, allowing citizens to have rich experiences and recognize the significance of such grey infrastructures in improving the resilience and sustainability of urban water environment.

Public engagement is also an important part in water environmental remediation and protection. In China, the cost on water treatment is far beyond the expense on environmental education. In a pilot river restoration project in Guangdong, BEGW appropriated part operation expenses to invest public engagement and reward the neighboring residents who clean or protect the river; a local volunteer organization was also funded to monitor and promote the long-term management and maintenance of the river site — the investment on public engagement and education might cost less than one tenth of the expenses on pollution remediation and restoration, while greatly propelling the integration of water infrastructures with citizens' daily life by letting people see, use, accept, and recognize them. **LAF**