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TREND EDITORIAL

The formation of discharge standards of pollutants for municipal wastewater treatment plants needs adapt to local conditions in China

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The process of standard improvement in Beijing

The river basin environment is of great value to the sustainable development of human society, which also has a profound impact on the economic development of the surrounding areas and the living quality of residents (Finkel and Normile 2012). One of the main factors affecting the water quality of the river basin is anthropogenic discharged sewage (Yu et al. 2019; Ma et al. 2020). In order to improve the environmental quality of surface water, raising sewage discharge standards to reduce pollution discharge has been considered the main way for a long time. Before the 2010s, MWTP across the country executed unified national standards. During this period, MWTP executed national discharge standards of pollutants were updated twice. Since then, some provinces and cities have successively issued the discharge standards for local MWTP (Fig. 1).

Beijing, for example, was the first city to propose the local standards. Figure 2 shows the evolution of the discharge standards of municipal wastewater plants in Beijing. It is reported that the discharge standard for Beijing MWTP was first implemented in accordance with the national standard "Integrated Wastewater Discharge Standard" (GB 8978–88), which was then replaced by GB 8978–1996. And then in 2002, the government issued the "Discharge Standard of Pollutants for Municipal Wastewater Treatment Plant" (GB 18,918–2002), detailing the discharge standards for MWTP. In order to strengthen the discharge control and management of MWTP in Beijing, the government issued the Beijing local standard "Discharge Standard of Water Pollutants for Municipal Wastewater Treatment Plants" (DB 11/890–2012) in 2012, and gradually improved the standards over time. Table 1 lists the respective requirements of different standards for COD, BOD_5, suspended solids (SS), ammonia nitrogen (NH_3–N), and total phosphorus (TP) discharged from Beijing MWTP into level IV and V water. After that standard upgrade, the discharge of COD and NH_3–N in municipal wastewater dropped significantly. According to a survey on the "Beijing Municipal Environmental Statistics Annual Report," the discharge of COD dropped from 78,292 (2012) to 38,232.9 t (2019) and NH_3–N dropped from 14,762 (2012) to 2703.5 t (2019) in municipal wastewater in Beijing. In order to improve the quality of water ecological system and protect the citizens from health hazards, it is necessary to promote the gradual raising of the discharge standards in consideration of economy and environment.

Focus on the significance of improving standards

As regulation has surged, the nationwide increase in discharge standards requires MWTP to transform and upgrade their model ensuring that the indicators of effluent meet the discharge standards (Liu et al. 2021). Thus, the upgrade standards leave many plants to face a contradiction, coordinating the advanced technology and low cost. As for MWTP, especially those in underdeveloped areas, it is impossible to apply advanced water pollution treatment processes and ensure consistent operation because of no sufficient

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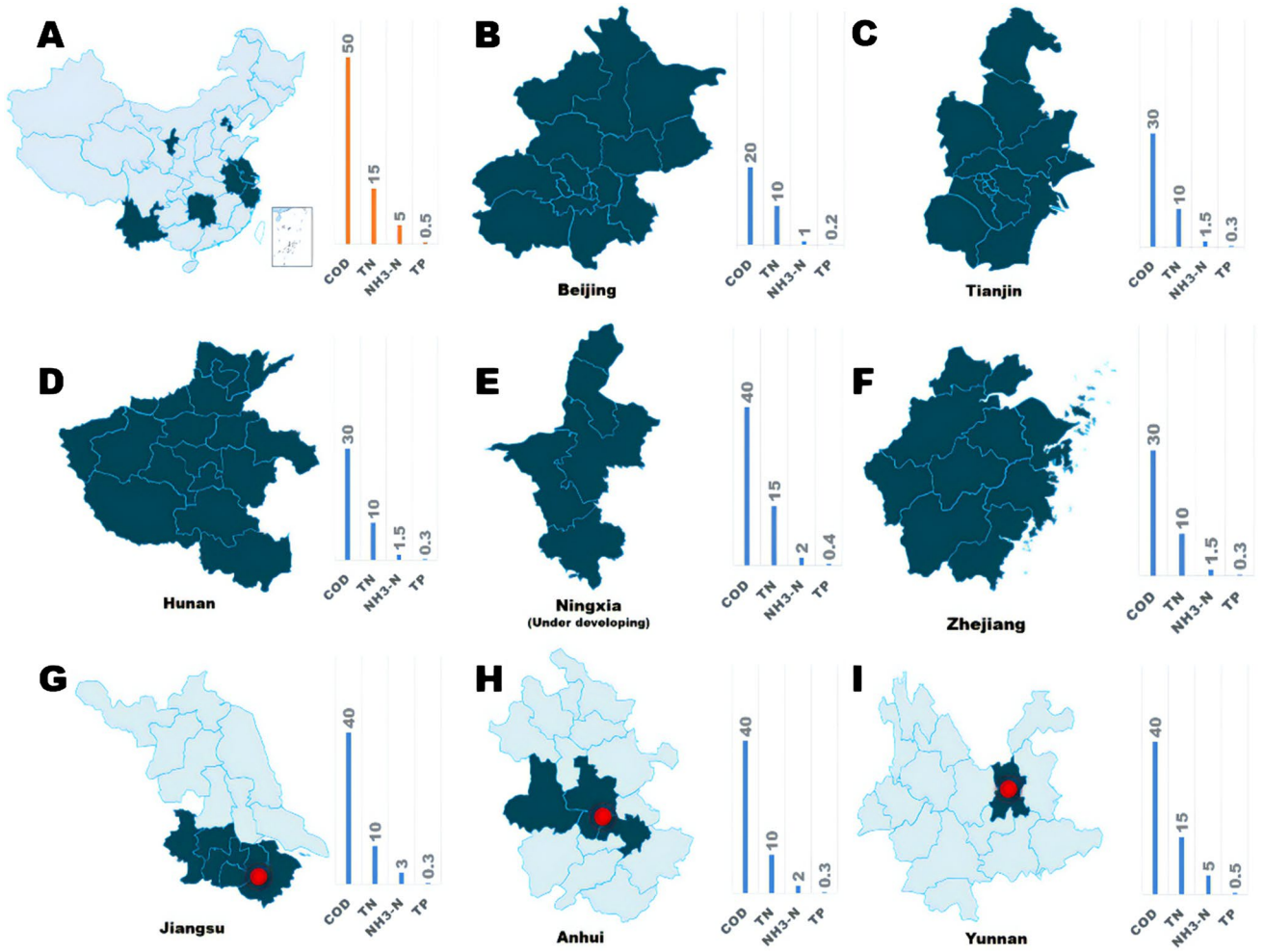

Fig. 1 Discharge standards for local municipal wastewater treatment plants in different regions of China ("B-I" shows the area that implements local standards in different provinces; the orange and blue histograms represent national and local standards, respectively; red dots indicate protected lakes)

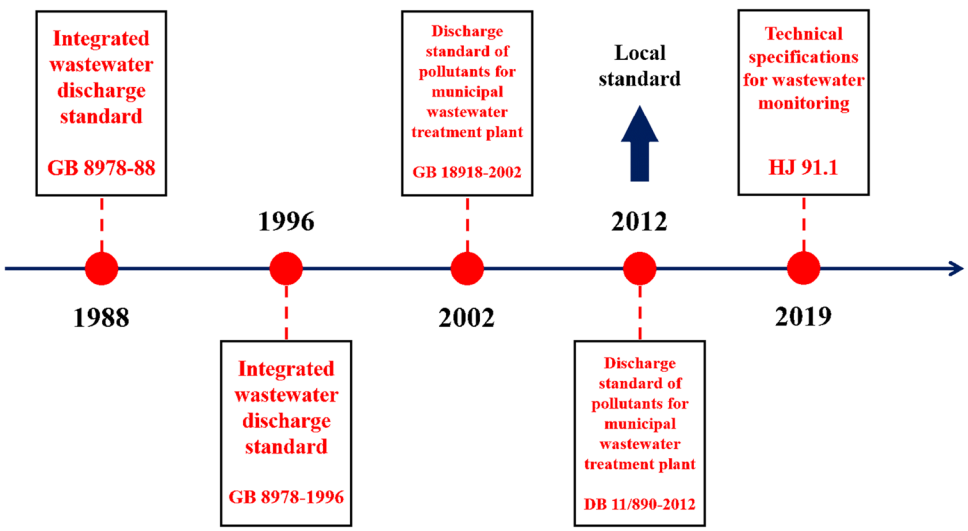

Fig. 2 Timeline of the discharge standards for municipal wastewater treatment plants in Beijing

Table 1 The main indicators of different standards for Beijing MWTP discharged into level IV and V water (mg/L)

Standard code	COD	BOD_5	SS	NH_3–N	TP
GB 8978–1996	120	30	30	25	-
GB 18,918–2002	100	30	30	25	3
DB 11/890–2012	30	6	5	1.5	1.5

Table 2 The main indicators in standards of different countries/regions (mg/L)

Country/region	COD	BOD_5	SS	TN	TP
China	50	10	10	15	0.5
Tutuila Island (USA)	-	100	75	-	-
Agana (USA)	-	30	30	-	8.0
European union	125	25	35	15	2.0
Japan	120	120	150	60	8.0

economic strength. In addition, careful evaluation is needed during and after the renovation when the investment and operating costs are increasing, so as to avoid too much economic pressure on both sides of local governments and MWTP. Therefore, the cities that promulgate local standards are those with better economic development.

Meanwhile, the practical significance of raising discharge standards should be concerned. Before the 2010s, in order to reduce the total discharge of pollutants in a quicker way, the government formulated three standards (GB 8978–88, GB 8978–1996, and GB 18,918–2002) on MWTP discharge to achieve an optimized management of water quality indicators. The discharge standards and management requirements of MWTP issued by various localities, such as Beijing and Tianjin, are mostly formulated on the basis of the national standard of "class I A," the highest level of the national standard, which is stricter than the standards of the USA, EU, and Japan (Su et al. 2022). Table 2 shows the comparison between Chinese standards and some international standards. First of all, the "class I A" discharge standards are formulated on the reuse of water resources. If the standards are implemented throughout the whole country, it will actually go against the intention of the standard setters. Secondly, it does not only need to realize the prospect of "green mountains and clear water are equal to mountains of gold and silver" but also needs to focus on the economic development in the process of environmental improvement (Liu et al. 2014). Policy-makers always tend to underestimate the additional economic and resource burdens caused by achieving more commendable environmental performance (Zhang et al. 2020). Finally, the self-purification ability of the environment should be considered. If the environment has enough carrying ability to the current discharge of pollutants, the discharge standards may be much too strict and not applicable to the environmental improvement (Qi et al. 2020).

It is worth noting that in 2016, the direction of pollutant discharge was changed in "Discharge Standards of Pollutants for Municipal Wastewater Treatment Plants" (draft for comments), and various standard values were proposed based on membrane technology. From the advice and suggestion of all parties, it was found that the undue technical requirements for municipal wastewater plants in most areas, and the capital demand was too large, while the practical significance was not strong. As the consequence, further work on standard formulation is needed. And the further revisions to the standard were attempted in 2022. This revision focuses on sampling and monitoring methods. According to the GB 18,918–2002, the wastewater sampling method was "At least once every 2 h, and determine the 24 h mixed sample by daily average." This sampling method may no longer suitable for the current situation because the emission fluctuation rules of different wastewater treatment processes are different. This amending list of the GB 18,918–2002 revised the sampling method (4.1.4 Sampling and monitoring) to "If HJ 91.1 stipulates that a mixed sample cannot be determined, each sample should be determined within 24 h." The HJ 91.1 mentioned here refers to the "Technical specifications for wastewater monitoring" standard promulgated in 2019, which made more detailed provision wastewater sampling and monitoring methods. Moreover, the expert at the press conference demonstrated that the revision will not increase the cost of the enterprise. This proves that the government not only pays attention to the environmental benefits but also the economic benefits.

Also, the high-level standards may cause negative effects. The energy consumption, chemicals, and carbon sources required by advanced water treatment processes are bound to increase (Bertanza et al. 2022). And it will lead to an increase in the carbon emissions of upstream plants, thus the possibility of secondary pollution. In addition, under the premise of high standards, continuing to improve a certain environmental index of standard may not significantly reduce its environmental toxicity. For example, the environmental toxicity of COD may vary differently in different industries. Generally, high value-added and high-profit industries can produce more toxic COD to the environment. Therefore, it is likely that industries with lower profits are required to reduce discharge, but those discharging pollutants with greater environmental toxicity are retained on the contrary. Therefore, blindly raising the level of discharge standards to achieve the so-called improvement of the ecological environment may confine the vision of local governments and ignore other possible effective methods.

Suggestions for local governments

To avoid those problems above, we present three suggestions here. First of all, local governments should conduct a systematic, comprehensive, and prudent assessment on the renovation and operating costs for the MWTP, and study local water environmental pollutant tolerance. Then, find the minimum municipal wastewater discharge standards meeting the reasonable energy consumption while ensuring the discharged water quality, and achieve the carbon neutrality target of the MWTP. Otherwise, political and cultural factors also need to be taken into consideration. Secondly, the focus should be placed on the rate of municipal wastewater disposal, including increasing the municipal wastewater pipelines and reducing non-point source pollution with reference to national conditions (Xue et al. 2022). Meanwhile, a nationwide water quality database from the perspective of temporal and spatial changes is needed (Farnham et al. 2017). Finally, with the help of a database, local governments should formulate standards based on regional characteristics and steadily promote the work of reduction of pollutants with directed attention, and take the toxicological effects of pollutants into consideration as well.

Environmental implication

The Chinese government has been committed to improving the water environment, which is crucial for national development and social progress. The quality of water from MWTP will directly affect the quality of water environment in the city. This paper outlines the improving process of discharge standards for MWTP in China, and takes Beijing as an example for a detailed description. Through our review and feedback from industry participants, it is found that the formulation of discharge standards for MWTP needs very careful consideration. The following noteworthy recommendations can be drawn:

- Local governments: Conduct a systematic, comprehensive, and prudent assessment of the local water environment and MWTP before formulating standards.
- MWTP: Combine economic benefit with environmental benefit and seek low input and high return wastewater treatment process.
- University: Pay attention to the practical application of technology to help MWTP achieve technological upgrading.

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Declarations

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Consent to participate Not applicable.

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