

Workshop on MAR in China 2021 (March 22nd, 2021)

Online meeting - China - Denmark

Water Reuse in China: Current Status, Policies and Experience

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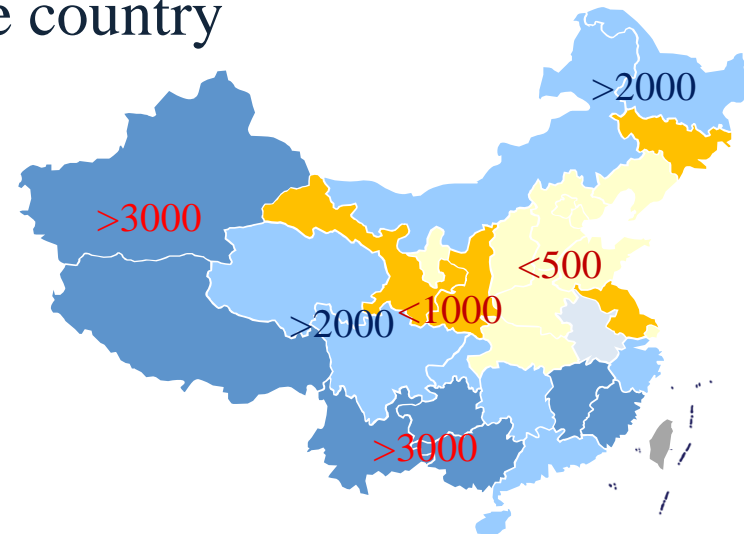
Outline

- **History and present status of water reuse in China**
 - Water environmental problems
 - History of water reuse
 - Wastewater discharge, treatment and reuse
 - Current practices of water reuse in megacities of China
 - Technologies for advanced treatment of secondary effluent
- **National Policy and Standards of Water Reuse in China**
- **Experience and case studies of Water Reuse in China**
- **Future Perspectives of Water Reuse in China**

1.1 Water Environmental Problems in China

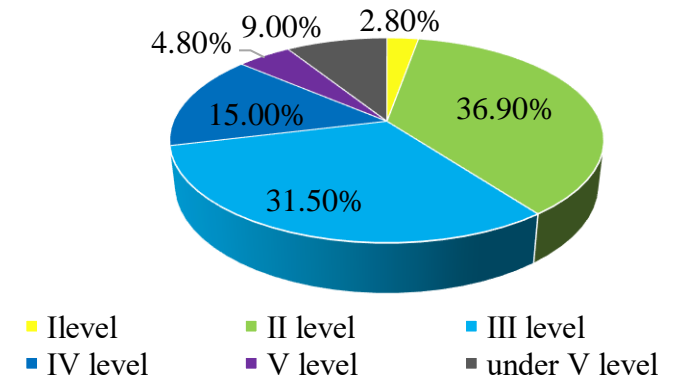
□ Water environmental problems across the country

- Water shortage
 - Two thirds of China's 661 cities are confronted with water shortage problems
 - Unbalanced distribution of water resource
- Water pollution
 - Black and malodorous water bodies
 - Eutrophication (algal bloom)



Water source per capita per year in China
(average **2,300 m³/capita/year** in 2017)

River water quality in China, 2018



1.1 Water Environmental Problems in China

❑ Water environmental problems across the country

- Water ecology destruction
 - Reduction of ecological habitat
 - Loss of biodiversity
- Water space recession



Dried and covered up water courses

❑ **Water reuse** – an **essential strategy** to alleviate water shortage problems and extend water supply capacity of cities



Industrial use



Irrigation

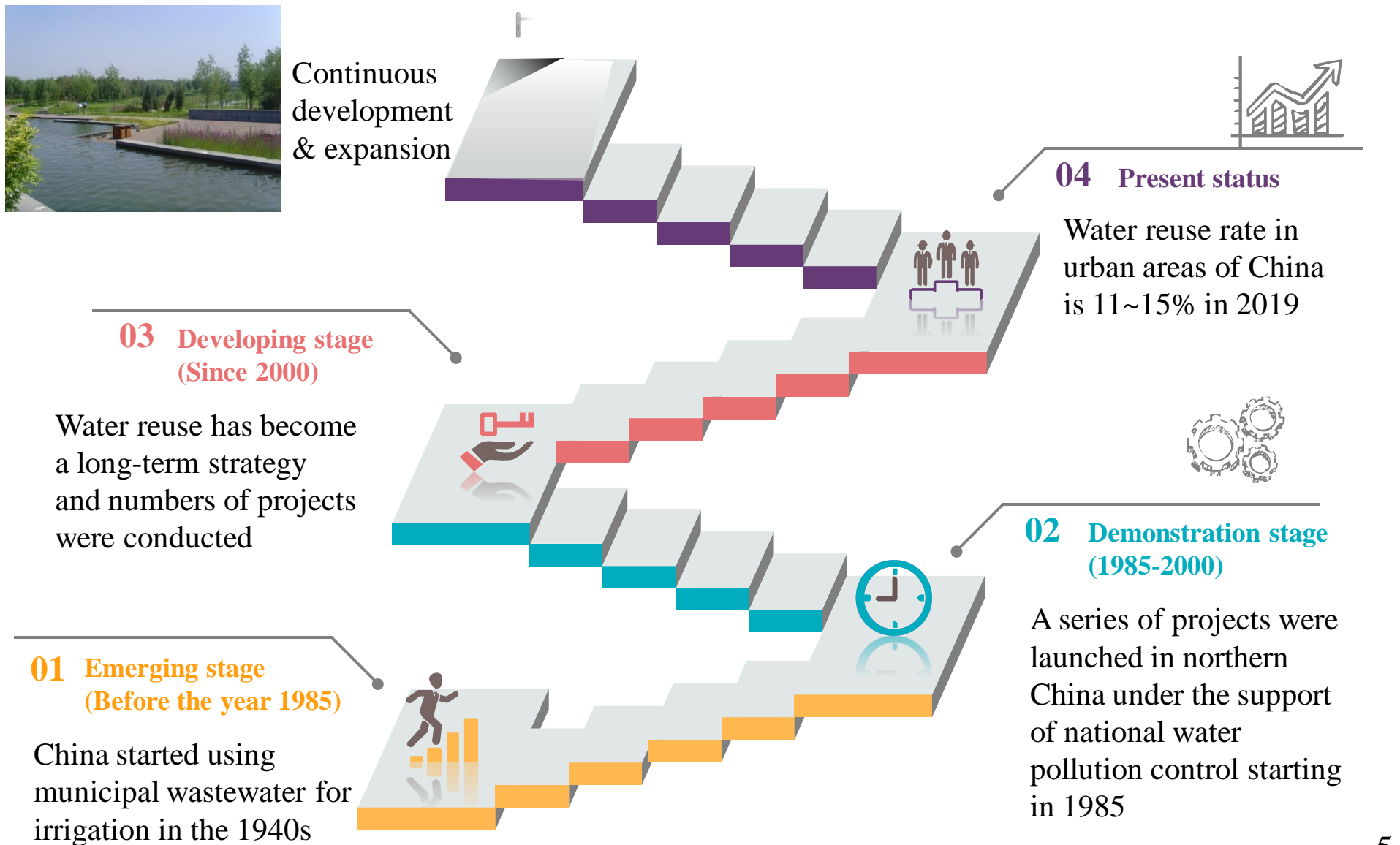


Environmental uses



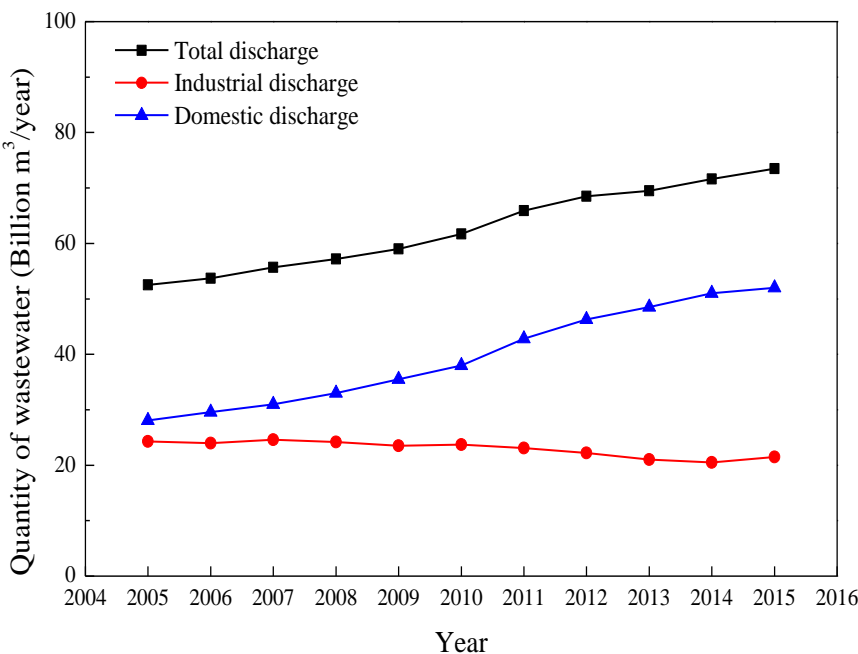
Water source supplementation

1.2 History of Water Reuse in China

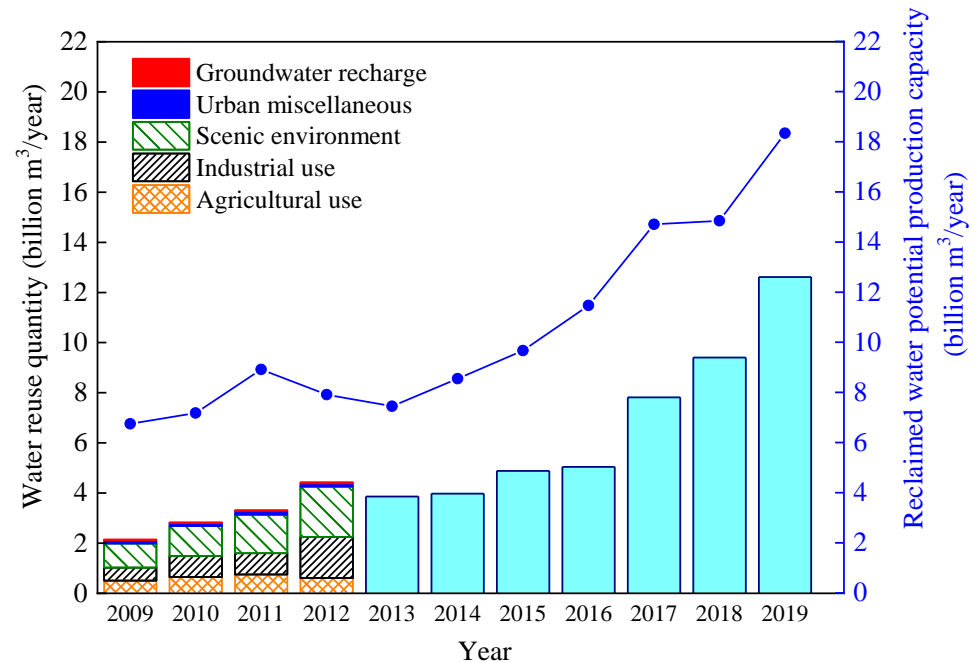


1.3 Wastewater Discharge, Treatment and Reuse in China

- By 2019, wastewater treatment capacity in urban areas reaches to $214.5 \times 10^6 \text{ m}^3/\text{day}$
- Reclaimed water use in urban areas of China reached to $12.62 \times 10^9 \text{ m}^3$ in 2019
- **Scenic environment** and **industrial applications** are the two largest applications of reclaimed water, representing over 80% of the total reclaimed water consumption



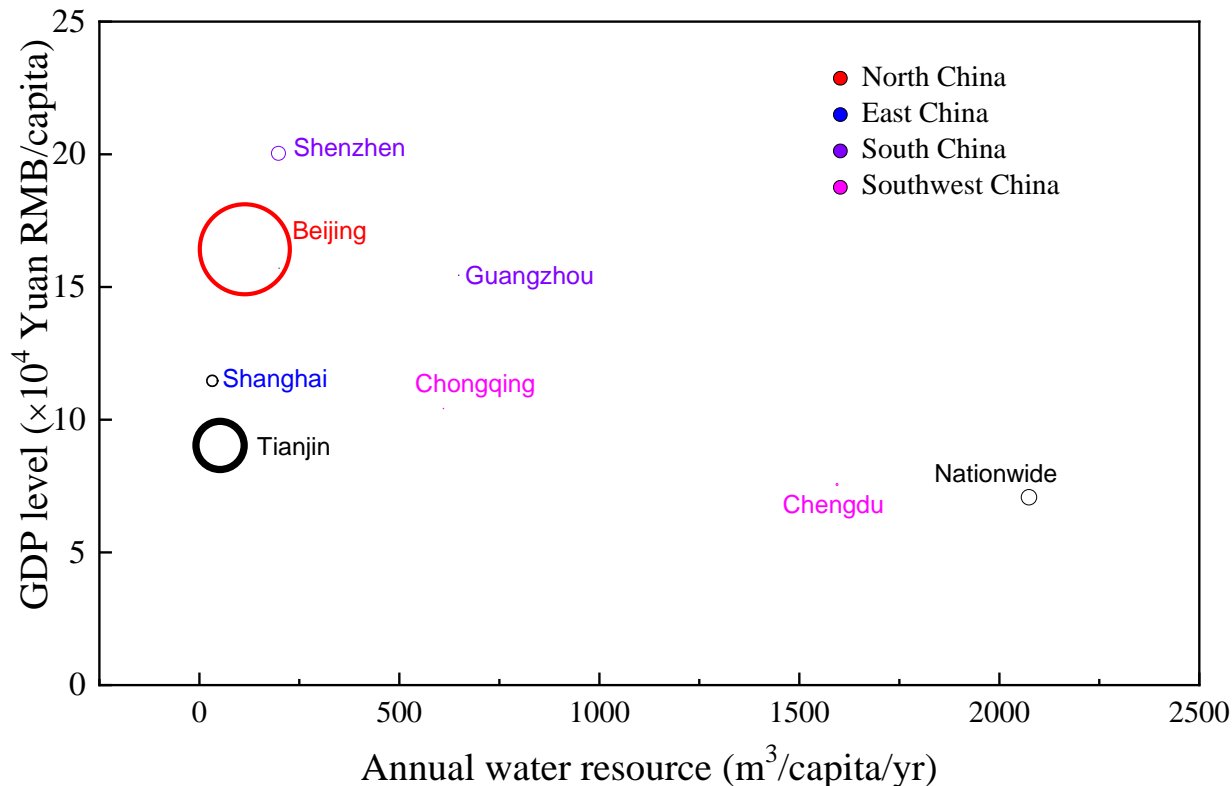
Wastewater discharge amount in China



Water Reuse Applications in Urban Areas of China

1.4 Current Practices of Water Reuse in Megacities of China

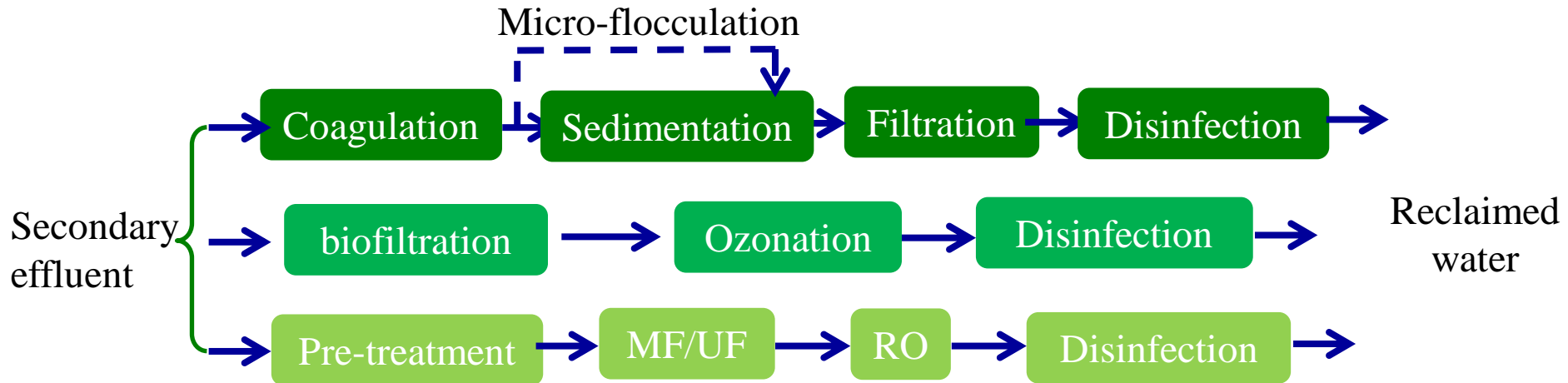
- 7 out of 34 megacities in the world are located in mainland China with more than 10 million people in each city
 - In north megacities such as Beijing and Tianjin, water shortage is the biggest obstacles
 - In south cities, surface water contamination and water quality deterioration are main issues



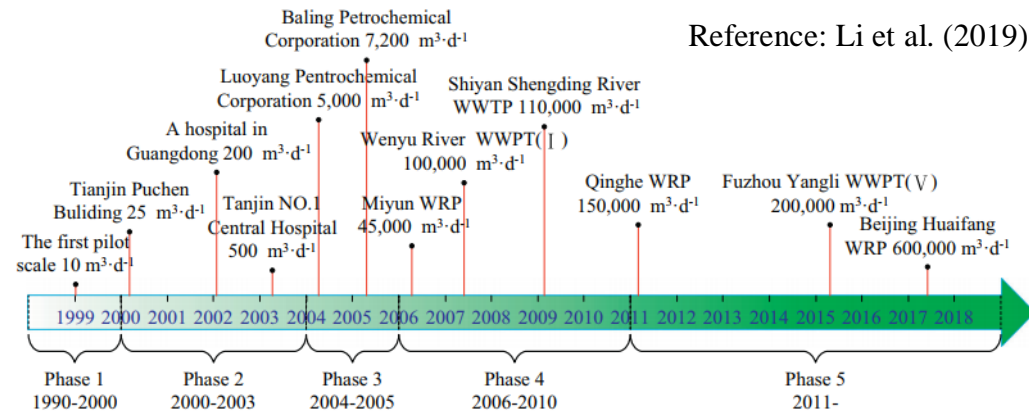
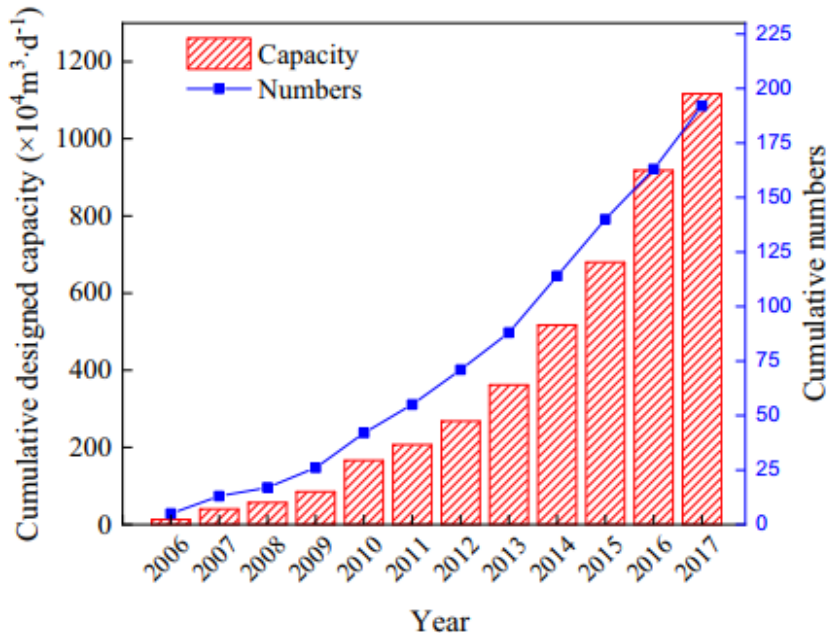
Correlations of the capacity of reclaimed water facilities (m³ per capita per year) in urban areas with water resource quantity and GDP level (data sourced from NBSC, 2015, Chen et al. 2017)

1.5 Technologies for Advanced Treatment of Secondary Effluent

- Advanced treatment technologies for water reuse



- Application of MBR technology in China



Development of engineering application of large-scale MBRs ($\geq 10,000 \text{ m}^3 / \text{d}$) in China

Outline

- History and present status of water reuse in China
- **National Policy and Standards of Water Reuse in China**
- Experience and case studies of Water Reuse in China
- Future Perspectives of Water Reuse in China

2 National Policy of Water Reuse in China

□ The State Council

- The Action Plan for Prevention and Control of Water Pollution (2015. 04)
 - Target: By 2020, water reuse rate will be 20% in water scarce cities and 30% in Beijing-Tianjin-Hebei Region
- Opinions on accelerating the construction of ecological civilization (2015. 05)
 - Encouraging wastewater reclamation and reuse, ensuring water resource safety insurance

□ National Development and Reform Commission

- The Guidance Document on Promoting Utilization of Wastewater Resources in China (2021.1)
 - Target: By 2025, water reuse rate will be 25% in water scarce cities and 35% in Beijing-Tianjin-Hebei Region

2 National Standards of Water Reuse in China

□ Design code

Municipal
Wastewater

《Code for design of water
reclamation and reuse》

《Code of design for water reuse
system in buildings》

Industrial
Wastewater

《Code for design of industrial
recirculating cooling water treatment》

《Code for design of wastewater treatment and
reuse of chemical industry》

《Technical specifications for wastewater treatment
and reuse of iron and steel industry (draft)》

2003

2008

2011

2 National Standards of Water Reuse in China

□ Water reuse standards in urban areas of China



2 National Standards of Water Reuse in China

- Water quality parameters specified in national standards

Parameter	Recreational use in rivers and lakes (GB/T 18921-2002)	Urban miscellaneous use (Chinese GB/T 18920-2002)			Industrial use (Chinese GB/T 19923-2005)		
		Toilet flushing	Road cleaning	Municipal landscape	Cooling water		Boiler water
					Once-through	Circulating	
pH	6-9	6-9	6-9	6-9	6-9	6.5-8.5	6.5-8.5
Color	≤ 30	30	30	30	30	—	30
Turbidity (NTU)	5	5	10	10	—	3	3
SS (mg/L)	—	—	—	—	30	—	—
TDS (mg/L)	—	1500	1500	1000	1000	1000	1000
BOD ₅ (mg/L)	6	10	15	20	30	10	10
COD _{Cr} (mg/L)	—	—	—	—	—	50	60
NH ₃ -N (mg/L)	5	10	10	20	—	10	10
Anionic surfactant (mg/L)	0.5	1	1	1	—	0.5	0.5
DO (mg/L)	—	≥ 1	≥ 1	≥ 1	—	—	—
TN (mg/L)	15	—	—	—	—	—	—
TP (mg/L)	1	—	—	—	—	1	1
Total coliform (cfu/L)	—	3	3	3	—	—	—
Faecal coliform (cfu/L)	500	—	—	—	2000	2000	2000
Chlorine residual (mg/L)	0.05	≥ 1.0 after 30 min contact time, ≥ 0.2 at point of use			0.05	0.05	0.05

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3.1 Water Reuse Models in Urban Areas of China

Water reuse models in urban areas of China

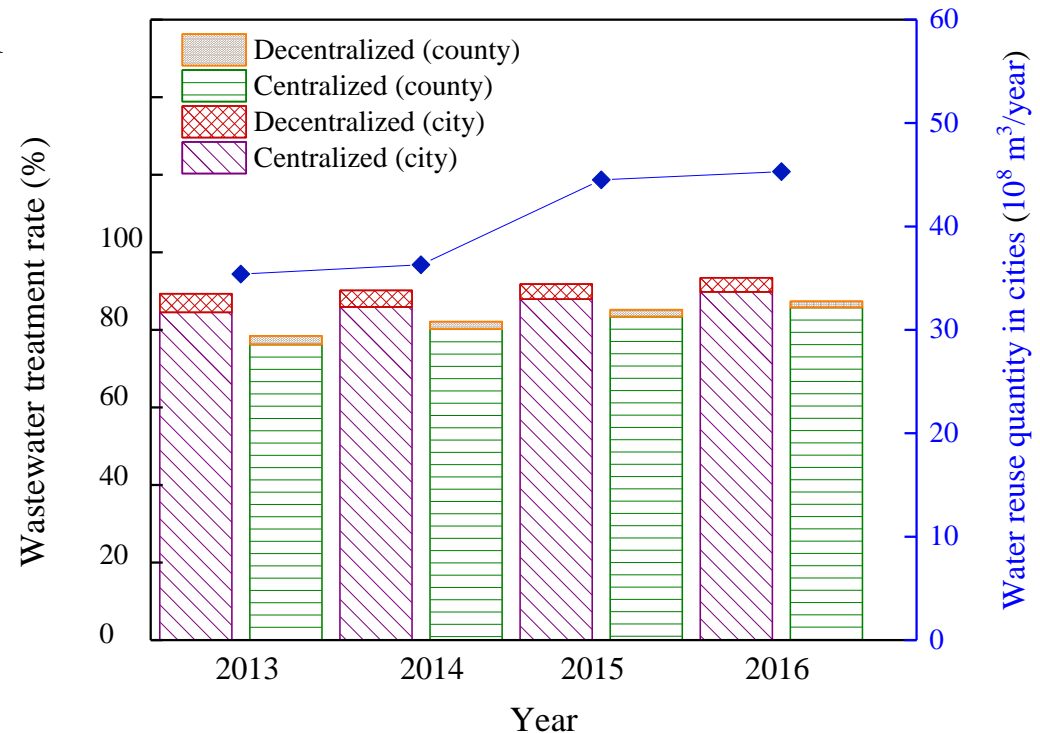
- Centralized Water Reuse System
- Decentralized Water Reuse System



Centralized Water Reuse System



Decentralized Water Reuse System



Proportion of centralized and decentralized wastewater treatment systems in urban areas of China (data sourced from MOHURC, 2015).

(Reference: Chen et al. 2017, Centralized water reuse system with multiple applications)

3.1 Water Reuse Models in Urban Areas of China

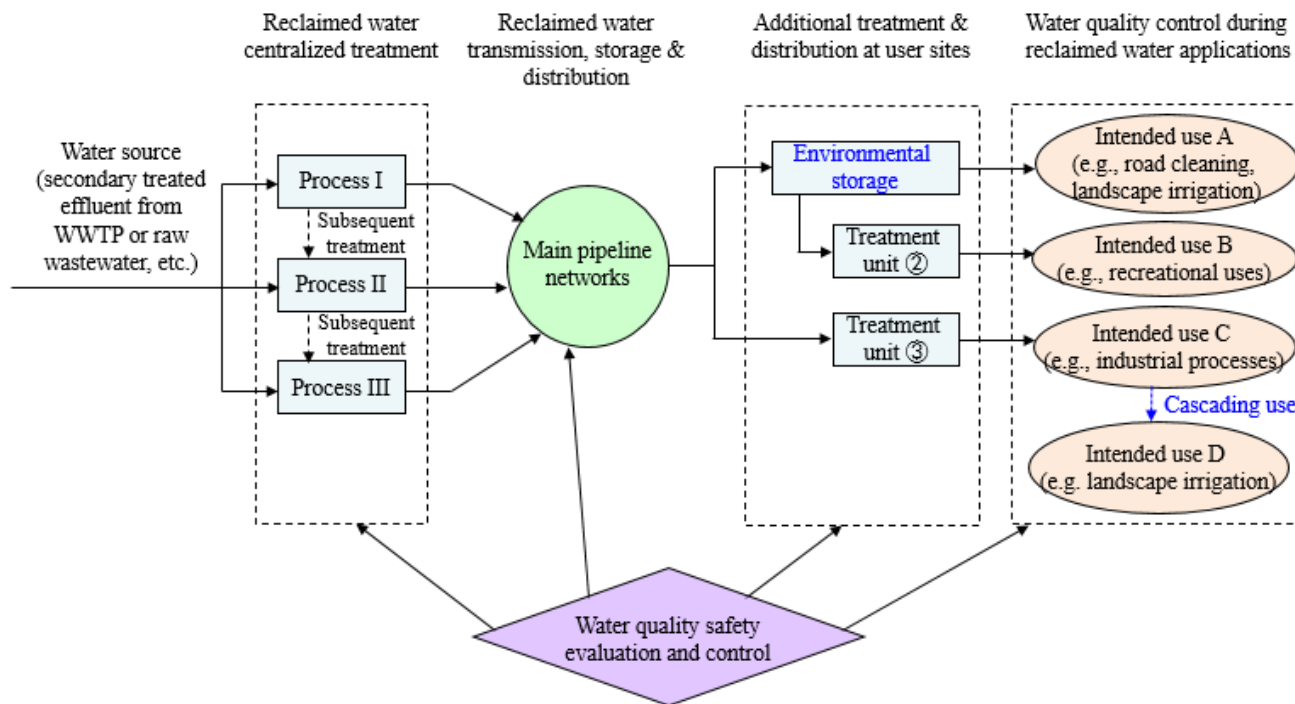
❑ Centralized water reuse in urban areas of China

• Technical approaches

- Multiple barrier approach & monitoring
- Minimum technological requirement

• Management approaches

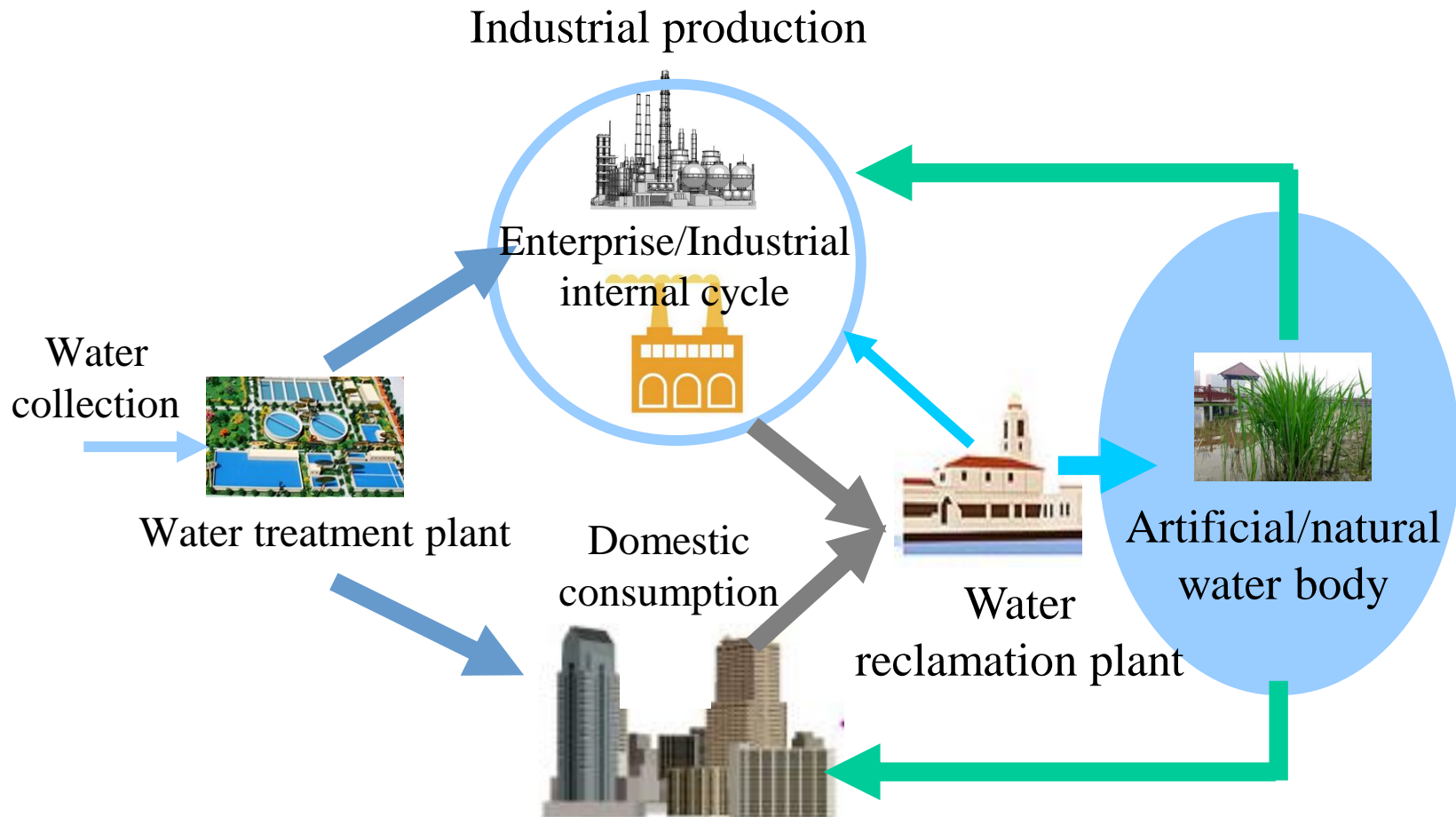
- Water quality standards
- Daily management (HACCP-Hazard Analysis and Critical Control Point)



Fit-for-purpose use
of reclaimed water
with different water
quality for multiple
applications

3.1 Water Reuse Models in Urban Areas of China

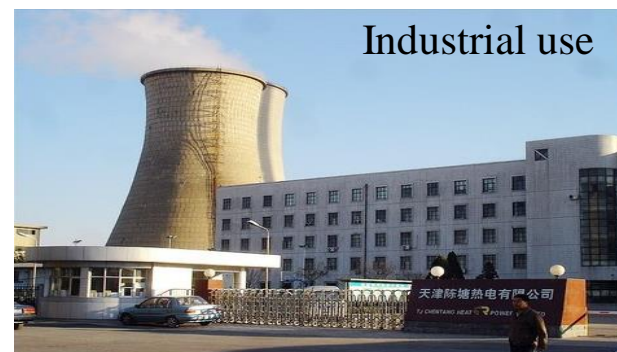
- Establishment of natural water body mediated-reuse systems of reclaimed water (**Cascade use of reclaimed water**)



3.2 Water Reuse in Tianjin

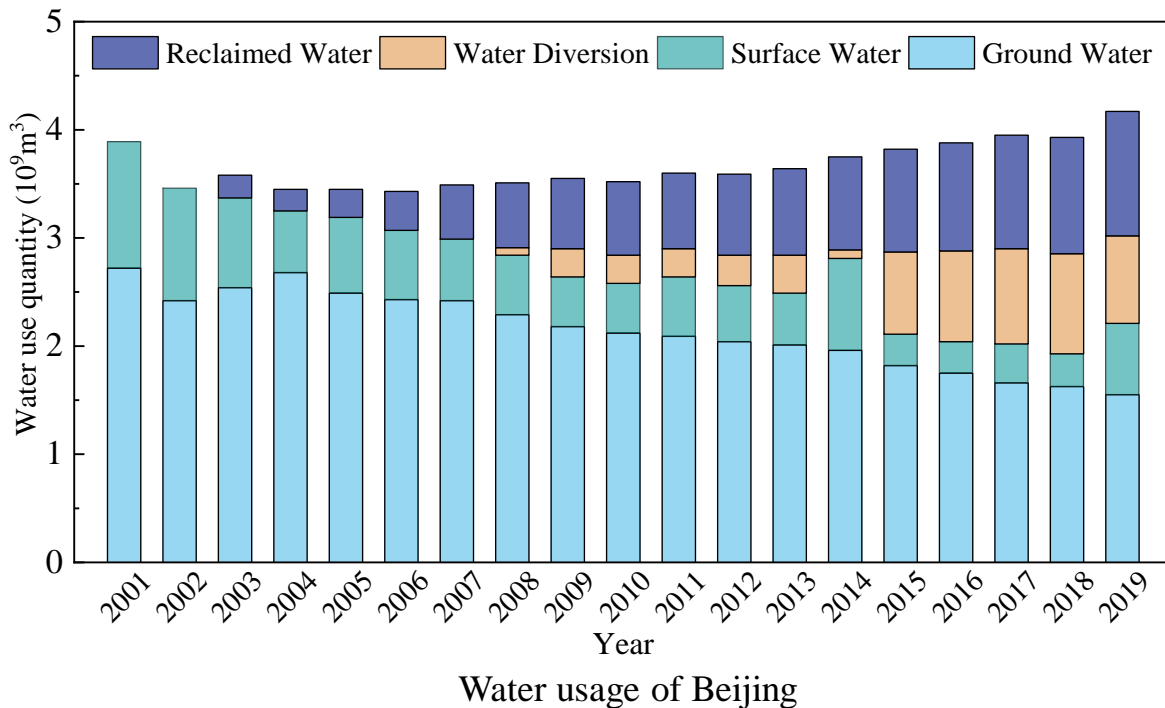
- Five water reclamation plants in central Tianjin (Design capacity: 250,000 m³/d)
- **Fit-for-purpose use**: reclaimed water from UF-Ozonation-Disinfection is for residential uses, reclaimed water from UF-RO is for industrial uses
- Main applications of reclaimed water: **residential use** (100,000 households), **industrial use** (17 enterprises) and **environmental use**

Main water resources	Water supply quantity (10 ⁴ m ³ /d)	
	Year 2015	Year 2020
External water diversion (from Luan River and South-to-North Water Transfer)	401.4	536.4
Surface water	45.5	45.5
Groundwater exploration	35.2	35.6
Reclaimed water	61	132.7
Sea water desalination	53	98
Total water supply	595.8	848.3



3.3 Water Reuse in Beijing

- In 2019, reclaimed water production capacity was $6.79 \times 10^6 \text{ m}^3/\text{d}$, and water reuse amount was $1.15 \times 10^9 \text{ m}^3$.
- Over 70% of lakes and rivers in Beijing are supplemented with high quality reclaimed water
- World largest water reclamation plant (Gaobeidian WRP, $10^6 \text{ m}^3/\text{d}$)



(data sourced from NBSC, 2020; BMEPU, 2020)



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4 Future Perspectives of Water Reuse in China

Calculation of water reuse potentials in China ($10^8 \text{ m}^3/\text{year}$)

Application	Current water reuse	Scenario 1 (Reach to Israel level: 80% of water reuse)		Scenario 2 (Reach to Beijing level: 68% of water reuse)		Scenario 3 (Reach to Singapore level: 39% of water reuse in industry)	
		Use potential	Projected reclaimed water production	Use potential	Projected reclaimed water production	Use potential	Projected reclaimed water production
All	45.3	313	358	259	305		
Environmental use	20.1			56	76		
Industrial use	16.4					45.5	62

Note:

- (1) All applications: wastewater generation amount in 2016: $448 \times 10^8 \text{ m}^3$, water reuse rate: 10%;
- (2) Industrial use: water reuse rate: 10.3%;
- (3) Environmental use: water reuse rate: 18.5%.

4 Future Perspectives of Water Reuse in China

- Large water reuse potential in China (water reuse rate is 11% nationwide and 68% in Beijing)
- Deep and long-term research on water quality control, especially on TAUs (Toxic, Assimilable and Unpleasant chemicals) control
- Establishment of integrated methodology for safety evaluation of reclaimed water
- Establishment of guidelines/standards on water reuse
- Implementation of natural water body as well as ground water

4 Future Perspectives of Water Reuse in China

- ❑ Important information from the latest national policy



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关于推进污水资源化利用的指导意见

Guidance Document on Promoting Utilization of Wastewater Resources in China

- **The definition of wastewater resources:** groundwater recharge is included
- **Pilot demonstration:** groundwater recharge is one of the important pilot demonstration projects

Thank you for your attention!

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Reclaimed Water in China: <http://www.reclaimedwater.net>



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