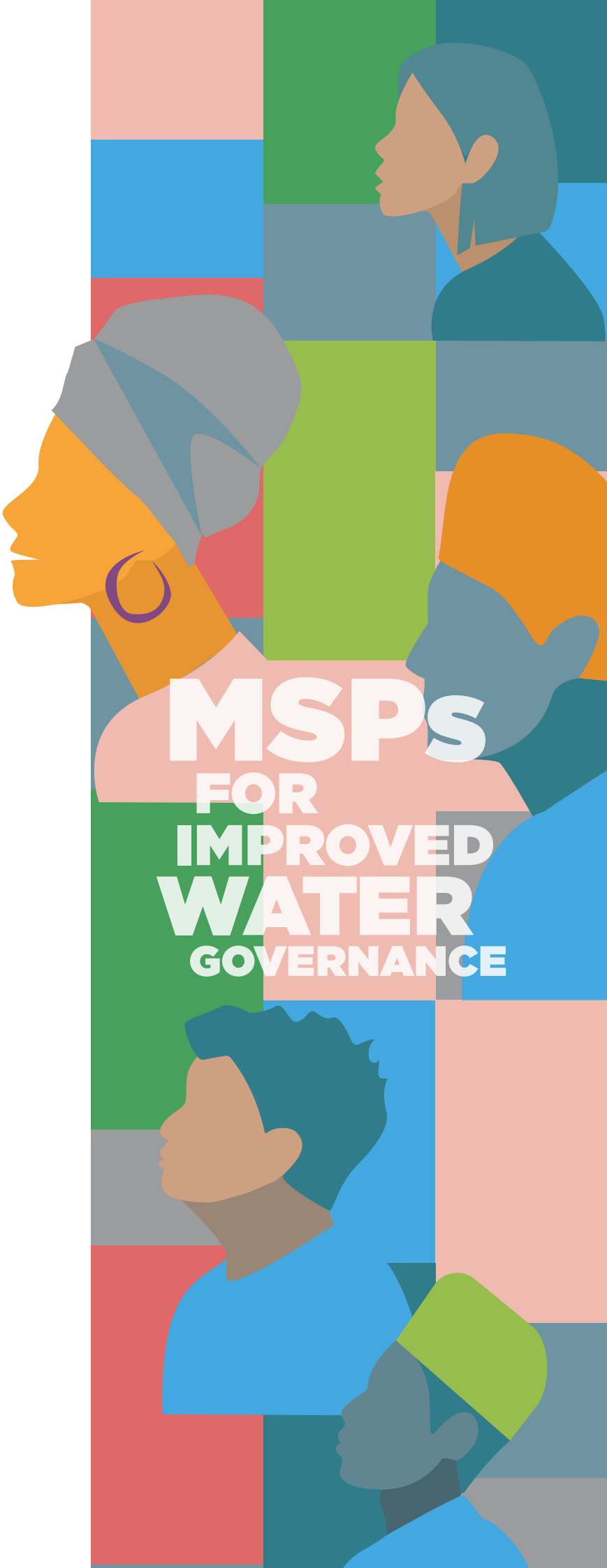
Partnerships for plastic pollution control in the Yangtze River

Strengthening coordination using the River Chief System



Global Water Partnership

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The views expressed in this document do not necessarily represent the official views of GWP or of hitherto mentioned partner organisations.

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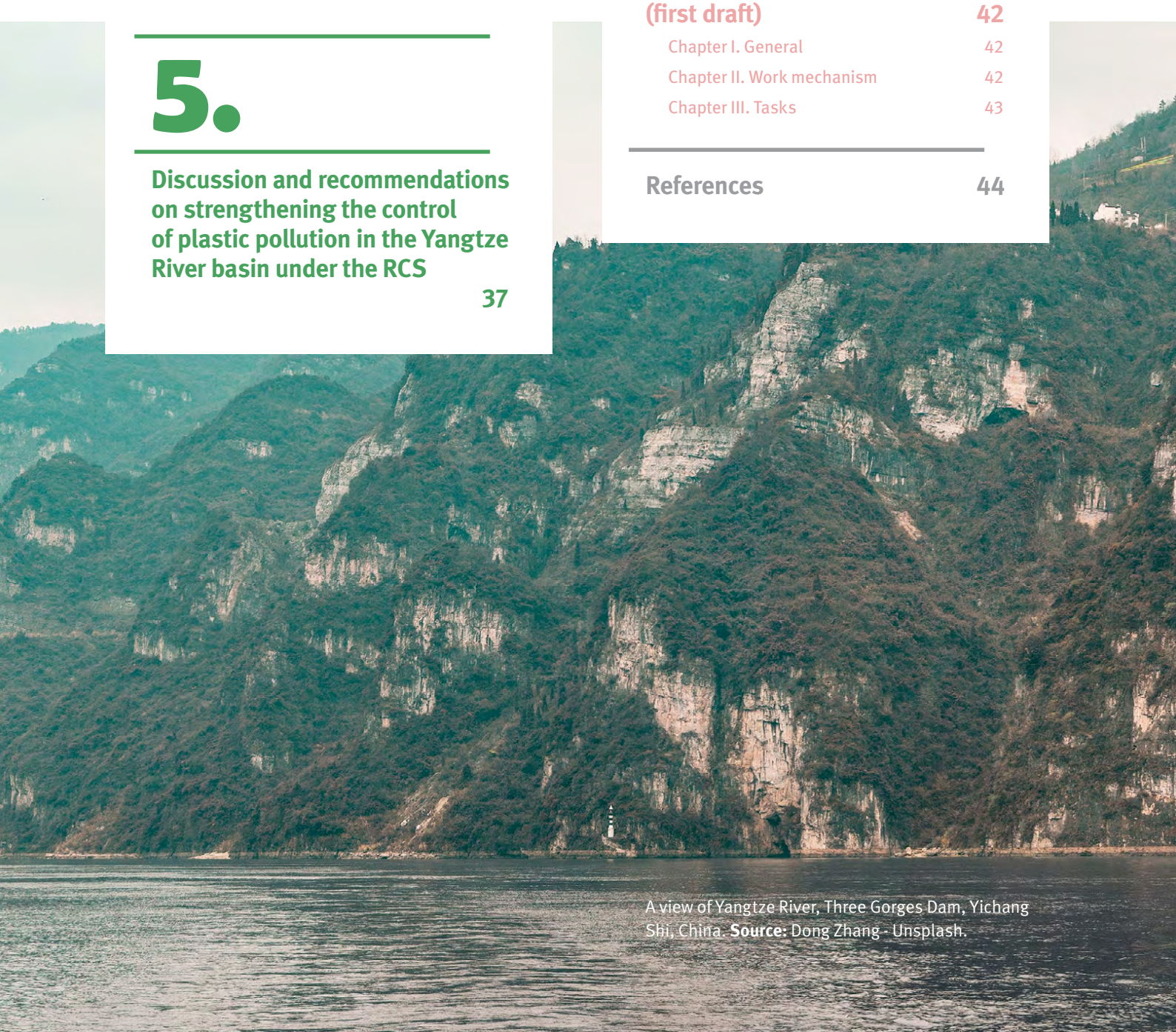

A view of Yangtze River, Three Gorges Dam, Yichang Shi, China. **Source:** Dong Zhang - Unsplash.

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ATEPW	Alliance to End Plastic Waste
CII	Commercial, industrial, and institutional
CPCIF	China Petroleum and Chemical Industry Federation
CSR	Corporate social responsibility
GWP	Global Water Partnership
IWRM	Integrated water resources management
MFA	Material flow analysis
MPW	Mismanaged plastic waste
MSP	Multi-stakeholder partnership
MSW	Municipal solid waste
NDRC	National Development and Reform Commission
NGO	Non-governmental organisation
ORCS	Office of the River Chief System
RCS	River Chief System
SWM	Solid waste management
S2S	Source-to-Sea
YREB	Yangtze River Economic Belt

1. Introduction

1.1. Background and rationale

Plastic pollution is globally distributed across coastal environments, with significant implications for ecosystems and organisms in a variety of forms. With an estimated 4.8–12.7 million tonnes of plastic waste entering the ocean, plastic pollution has been an ever-increasing marine environmental concern (Yang et al., 2020). Currently, 5.25 trillion plastic particles weighing 260,000 tonnes are floating at sea, the majority of which are less than 5 mm in size (Cohen et al., 2019). Plastic debris in the ocean is hazardous waste, because plastic absorbs toxic pollutants while it traverses through the environment. Plastic particles pose a hazard for numerous marine industries and are an aesthetic issue for the tourism industry. Rivers are the main source of ocean plastic pollution. Approximately 1.15–2.41 million tonnes of plastic waste generated from rivers enter the ocean every year (Lebreton et al., 2017).

The Yangtze River is one of the world's biggest basins, with a very high amount of mismanaged plastic waste (MPW) generation (Meijer et al., 2021). The Yangtze River Economic Belt (YREB) accounts for over 40 percent of China's population, and represents 37 percent of China's output of primary plastics (National Bureau of Statistics of China, 2020). The abundance of microplastic in the middle and lower reaches of the Yangtze River is at an intermediate level compared with other rivers worldwide (Xiong et al., 2019). However, due to the river's large flow, microplastic pollution in the Yangtze River needs more attention. An estimated 540–910 tonnes of microplastic flow through the surface layer of the Yangtze estuary into the ocean each year (Zhao et al., 2019). The plastic waste discharged in the waterways is transported via several environmental media, including surface runoff, agricultural activities, and effluents from industrial and domestic wastewater. For instance, a recent study in Changzhou, which is located in the lower reaches of the Yangtze River basin, found that the levels of microplastics in the wastewater of industrial plants were in the range of 8–23 n/L and that those from livestock farms and fish ponds were in the range of 8–40 and 13–27 n/L respectively (Wang et al., 2020). However, due to a lack of long-term systematic monitoring, data on plastic and microplastic pollution in the Yangzte River remains indicative only.

> **Approximately 1.15–2.41 million tonnes of plastic waste generated from rivers enter the ocean every year**

In this context, the Government of the People's Republic of China has been gradually implementing a series of plastic pollution control policies, covering the production, distribution, use, recycling, and end disposal of plastic products throughout the process. Plastic pollution control not only requires the Government to increase governance and planning, but also requires enterprises to take the initiative and fulfil their responsibilities. However, at present, enterprises are not closely enough connected with the Government, and public participation is not high in this regard. As such, there is a pressing need to establish a multi-stakeholder relationship to form a government-led responsible enterprise, and a public participation system, that can tackle the problem of plastic pollution in the Yangtze and the rest of China.

1.2. Objectives and methodology

The objective of this paper is to explore the potential of capitalising on the River Chief System (RCS) as a multi-stakeholder partnership (MSP) mechanism to enhance the coordination of plastic and microplastic pollution control and monitoring in the Yangtze River.

Towards this objective, we conducted a material flow analysis (MFA) using a survey of academic and grey literature to obtain an understanding of the main consumption, disposal, and management patterns, as well as the distribution of plastics in the main environmental mediums of a typical section of the Yangtze River. We additionally carried out an institutional analysis based on a desk review of the available documents, including studies, academic articles, and government papers, to establish a detailed picture of the management practices for plastic pollution control in rivers, and an outlook on the role and potential of the RCS. Findings were further discussed and validated through a multi-stakeholder consultation process involving over 20 participants, including officials from the Office of the River Chief System, private sector representatives, and other actors involved in plastic pollution control in the Yangtze River basin area.

1.3. Organisation of the paper and key findings

This paper is organised in five sections. First, we provide an overview of the plastic pollution situation in the Yangtze through the MFA conducted for Anhui Province, which suggests that approximately 175 tonnes/day of MPW end up in the ocean.

In the second section, we present the various laws and regulations that have been put in place to limit plastic pollution in the Yangtze and in China more broadly.

We proceed, in the third section, to a critical institutional analysis which reveals key gaps in terms of legal coherence, regulatory enforcement, departmental cooperation, regional coordination, monitoring and assessment, and corporate engagement.

In the fourth section, we detail the RCS and its suitability as an institutional mechanism to enhance coordination of plastic pollution monitoring and control. It is noted that from a legal and regulatory perspective, the RCS has a legitimate responsibility for engaging in plastic pollution and control. Through the institutional analysis, we additionally demonstrate its great potential in terms of enhancing watershed-wide coordination, promoting multi-departmental coordination, broadening participation, and strengthening the relationship with enterprises.

In the fifth and final section of this paper, we present our main recommendations on how to enhance multi-stakeholder coordination for plastic pollution monitoring and control. Our key recommendations include: (i) establishing a special coordination mechanism for the control of plastic pollution; (ii) strengthening interdepartmental collaboration for strict control of plastic pollution throughout the whole process; (iii) building an improved joint enforcement and regulation mechanism to strengthen joint inspection and regulation of plastic pollution; (iv) promoting monitoring, evaluation, and information sharing of plastic pollution in the basin; and (v) building a multi-stakeholder collaboration mechanism for the control of plastic pollution in the Yangtze River basin to guide the participation of multiple actors.

2. Material flow analysis

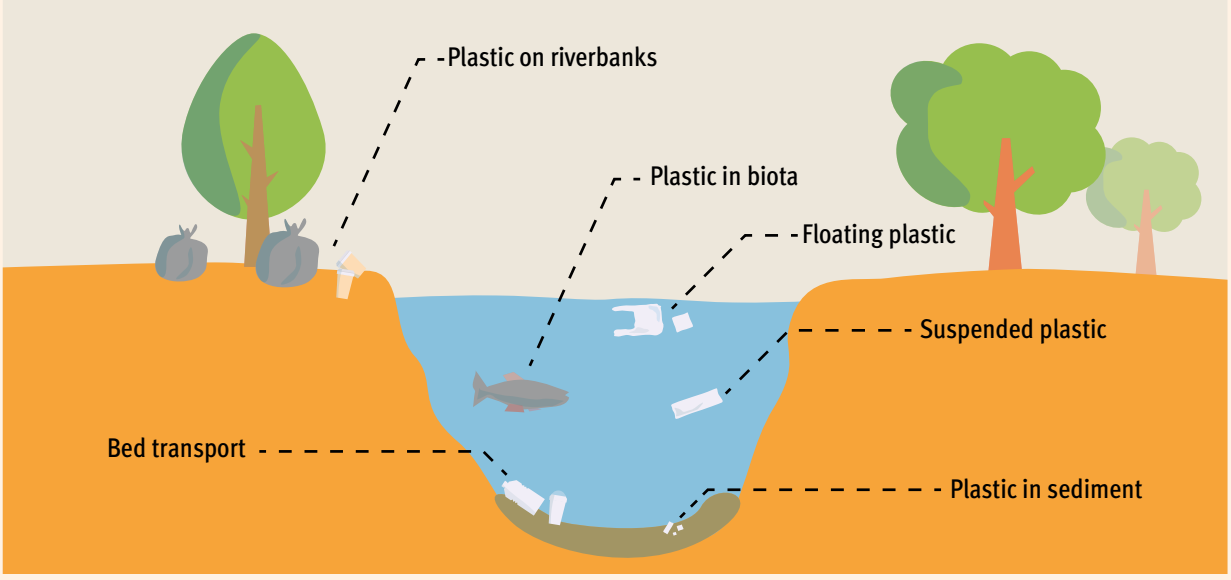
We conducted a MFA in Anhui Province, in the lower reaches of the Yangtze, to obtain a technical understanding the pathways and flows of plastic pollution and assess the amount of plastic discharged in a typical section of the Yangtze.

This section describes the methodological process behind our MFA model, as well as our estimations of MPW produced in the study area.

2.1. Defining plastic pollution in waterways

Before discussing the MFA, it is first important to understand the various types of plastics debris and how are they transported into rivers and oceans. Plastic debris in water bodies can be classified as macro-, meso-, and microplastics. Macroplastics are the largest category of plastic debris in the marine environment, with a size of >25 mm (Zhang et al., 2020). Macroplastics can fragment into mesoplastics (size 5–25 mm), which can further break down into microplastics (Amaral-Zettler, Zettler, and Mincer, 2020). Microplastics, broadly defined as plastics that measure <5 mm in diameter, are categorised into primary and secondary types (He et al., 2019). Primary microplastics, including cosmetics, medicine, synthetic fibres, and raw materials used for plastic production, directly enter the oceans as micro-sized particles, while secondary microplastics are mainly derived from the disintegration of large plastic materials through mechanical action, biodegradation, photo-degradation, photo-oxidative degradation, and other processes (Danso, Chow, and Streit, 2019). Unlike macroplastics, microplastics are not readily visible to the naked eye. Within oceanic environments, microplastics are widespread and ubiquitous, and they pose a serious threat to the marine ecosystem. A small fraction of microplastics is considered bioavailable to zooplankton (Lv et al., 2019). With their relatively large surface area, microplastics tend to adhere to waterborne pollutants and leach toxic plasticisers (Koelmans et al., 2019). Depending on their size and density, plastic debris can be floating, suspended, on riverbeds, and on banks, but can also be found in biota (Figure 1).

Figure 1. Plastic debris in rivers. **Source:** adapted from van Emmerik and Schwarz (2020).



2.2. Study area

The selected location of this study is situated in the YREB, which is composed of seven provinces, two special administrative regions, and one autonomous region situated in the Yangtze River basin in China: Anhui, Hubei, Hunan, Jiangsu, Jiangxi, Sichuan, Yunnan, Chongqing, Shanghai, and Guizhou (Figure 2). The YREB represents 23 percent of China's land area (Table 1), 43 percent of the nation's population (Table 2), and 46 percent of the national economy (National Bureau of Statistics of China, 2020). The YREB is split into three regions, the lower, middle, and upper reaches. The lower reaches are densest in population, whereas the middle and upper reaches are less so.

For this paper, the MFA was performed based on Anhui Province, located in the eastern part and lower reaches of the Yangtze River. It is about 570 km from south to north, and 450 km from east to west, covering an area of 140,100 km^2, about 1.45 percent of the total area of the country. By the end of 2019, the total number of permanent residents in Anhui was 63.66 million.

Figure 1. Map of the Yangtze River Basin. **Source:** Lehner and Grill (2013); United Nations Office for the Coordination of Humanitarian Affairs (OCHA) (2020); Esri (2022).

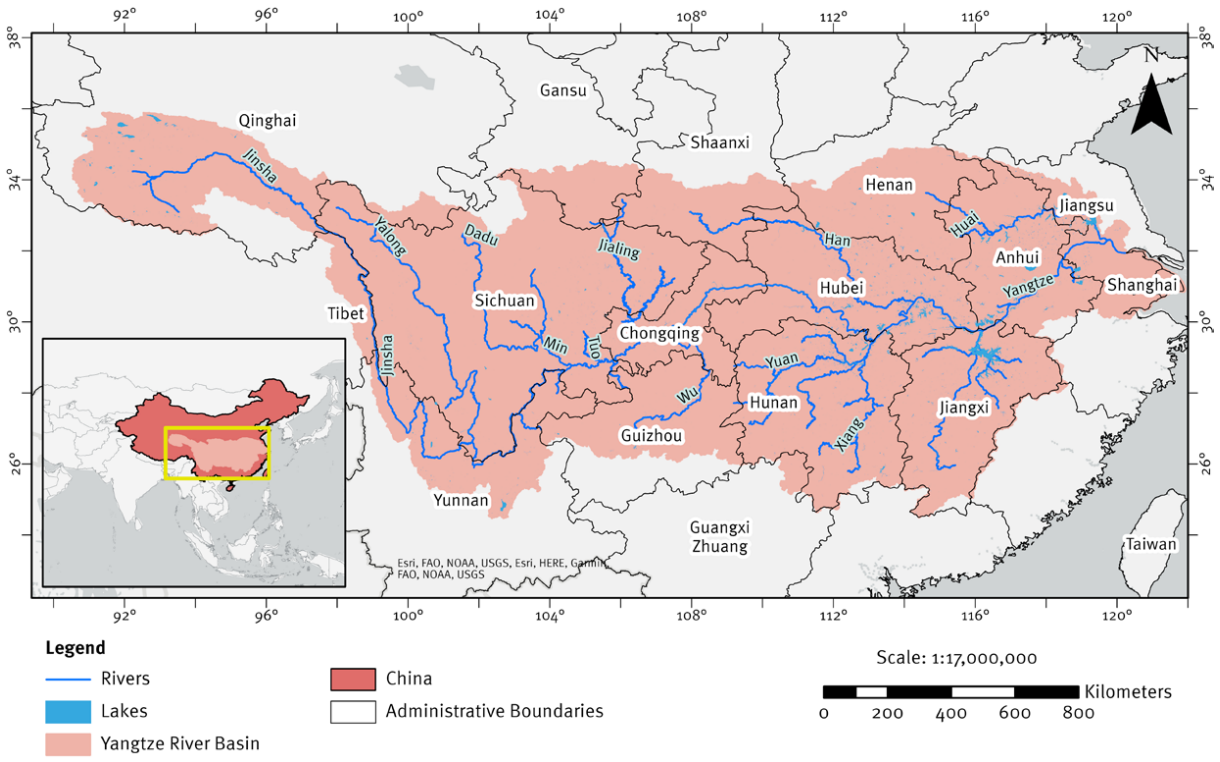


Table 1. Area of the Yangtze River Economic Belt (km²).
Source: National Bureau of Statistics of China (2020).

	Province	Area
Lower reaches	Anhui	140,100
	Jiangsu	102,600
	Shanghai	6,300
	Zhejiang	105,500
Middle reaches	Hubei	185,900
	Hunan	211,800
	Jiangxi	166,600
Upper reaches	Chongqing	84,000
	Guizhou	176,200
	Sichuan	486,000
	Yunnan	394,000
	Total area	**1,956,400**
	National area	**9,601,000**
	Proportion of national area	**20.4%**

Note: As all areas are rounded to 100 km², total figures and percentages may not match precisely.

Table 2. Permanent population of the Yangtze River Economic Belt (2019).
Source: National Bureau of Statistics of China (2020).

	Province	Urban (million)	Rural (million)
Lower reaches	Anhui	3,553	2,813
	Jiangsu	5,698	2,372
	Shanghai	2,144	284
	Zhejiang	4,095	1,755
Middle reaches	Hubei	3,615	2,312
	Hunan	3,959	2,959
	Jiangxi	2,679	1,987
Upper reaches	Chongqing	2,087	1,037
	Guizhou	1,776	1,847
	Sichuan	4,505	3,870
	Yunnan	2,376	2,482
	Total population	**36,487**	**23,718**
	Proportion of population	**61%**	**39%**
	National population	**84,843**	**55,162**
	Proportion of national population	**43%**	**43%**

Note: As all population figures are rounded to 10,000, total figures and percentages may not match precisely.

2.2. Route of material flow analyses

The MFA was conducted based on a 10-step methodological process. The steps were as follows:

1. Define the study boundaries and the characteristics of the selected basin (i.e. Anhui Province within the YREB region).
2. Find out how solid waste management (SWM) occurs on a provincial/municipal level, including through which companies, where and at how many sites, and the extent of management (i.e. the process). See if the National Bureau of Statistics of China has any papered values or if the management sites themselves have (self-) papered values.
3. Find the most common sources of waste generation (e.g. households, commercial, industry).
4. Find out the waste composition of the study area (e.g. 70 percent organics, 6 percent paper, 2 percent glass, 10 percent other, and 12 percent plastics). This can be done on a basin, provincial, or even municipal level.
5. Calculate the study area's waste generation rate (tonne/day or tonne/year) in sum and by type of waste, and waste service coverage (percent). Whatever is not covered can potentially be assumed to be the amount of uncontrolled plastic waste.
6. Calculate how much and which plastics are recycled.
7. Establish if there are any waste reduction efforts in place, and calculate what percentage of plastics are picked up.
8. Assess how much uncollected plastic is being picked up by others (informal waste management).
9. Find out the fates of uncollected plastics (e.g. land, soil, water) – what percentages of uncollected plastic and total plastic generated end up in waterways?
10. Based on the values obtained in no. 8 above, calculate the amount of plastic that ends up in waterways per capita (tonne/person/day).

2.3. Solid waste generation management and sources

The MFA relied on National Bureau of Statistics of China (2020) as a primary data source. We additionally consulted Kaza et al. (2018), which provided data on SWM in different countries at national and urban levels.

Based on those sources, it is estimated that China generates 2.10 × 108 tonnes of municipal solid waste per year. A large portion (61 percent) of this is attributed to food and organic waste (Table 3). Plastic waste represents 9.8 percent of the waste composition. A total of 94 percent of the urban population's waste is collected, whereas only 20 percent of the rural population's waste is collected. About 90 percent of waste is either sent to landfill or is incinerated (Table 4).

Table 3. China's waste composition (2019).
Source: Kaza et al. (2018).

Type of waste	Proportion (%)
Food-organic waste	61.2
Glass	2.10
Metal	1.10
Paper and cardboard	9.60
Plastics	9.80
Rubber and leather	1.30
Yard, garden, and green waste	0.00
Wood	1.80
Other	13.1

Table 4. China's waste composition (2019).
Source: Kaza et al. (2018).

Type of waste	Proportion (%)
Landfill (unspecified)	60.0
Incineration	29.8
Dump	8.2
Composted	3.0

Note: Total figures were rounded to 100, and percentages may not match precisely.

As shown in Table 5, in 2019, the YREB represented 37 percent of China's output of primary plastics, generating 36,164,500 tonnes of plastic per year. Of the three reaches, the lower reaches produced 81 percent of the primary plastics generated in the YREB, largely from Jiangsu and Zhejiang. The middle and upper reaches represented 8.6 percent and 10.4 percent of the output respectively.

Table 5. Output of primary plastics in the Yangtze River Economic Belt (2019).
Source: National Bureau of Statistics of China (2020).

	Province	Primary plastics (tonnes)
Lower reaches	Anhui	2,008,800
	Jiangsu	11,382,400
	Shanghai	4,314,100
	Zhejiang	11,558,700
Middle reaches	Hubei	2,034,300
	Hunan	589,600
	Jiangxi	484,400
Upper reaches	Chongqing	464,500
	Guizhou	80,400
	Sichuan	2,818,700
	Yunnan	430,600
	Total output	**36,166,500**
	National output	**97,436,500**
	Proportion of national output	**37%**

Note: As all areas are rounded to 100, total figures and percentages may not match precisely.

Information on SWM can be organised as shown in Table 6. Anhui Province was taken as an example for the following MFA.

Table 6. Summary of solid waste management in Anhui Province.

Cluster	SWM service provided	Collection frequency
Rural areas	Primary collection	Self-organised
	Transfer stations/points	
	Secondary collection	
	Waste disposal	
Urban areas	Primary collection	Daily
	Transfer station/points	
	Secondary collection	
	Waste disposal	

After the types of management and sources of solid waste have been tabulated, the waste composition can be collected based on related documents (Table 7), reflecting the local data and assessed against other Chinese data available (Kaza et al., 2018; Ma et al., 2021; World Wide Fund for Nature, 2020). Organic matter accounts for the largest proportion of waste, with a total of 52 percent. Plastics accounted for 16 percent.

Table 7. Waste composition in Anhui Province (2019).
Source: Ma et al. (2021); Kaza et al. (2018); World Wide Fund for Nature (2020).

Type of Waste	Proportion (%)
Organic matter	52%
Paper and cardboard	12%
Textiles	11%
Metals	4%
Leather and rubber	3%
Plastics	16%
Other	2%

2.4. Waste and plastic generation estimate

Calculation factors for solid waste and plastic waste generation in Anhui Province have been determined (Table 8). According to the urban garbage volume and population of Anhui Province in 2019, the urban waste generation rate is estimated at 0.55 kg/person/day (National Bureau of Statistics of China, 2020). The rural waste generation rate at 0.43 kg/person/day (Anhui Provincial Department of Housing and Urban-Rural Development, 2020). Depending on the main sources of waste identified in the previous section and investigation, commercial, industrial, and institutional (CII) waste values, the plastic fraction of MSW, and estimated reduction efforts are collected.

The total amount of waste is composed of household waste and commercial waste. It is calculated that the total amount of waste and plastic is 38,096 tonnes/day and 5,822 tonnes/day respectively (Table 9). According to Kaza et al. (2018), garbage collection rates in China were 94 percent in urban areas and 20 percent in rural areas in 2011. The total amount of uncollected waste and plastic waste was 12,399 tonnes/day and 1,765 tonnes/day respectively. The average garbage collection rate in Anhui Province reached 67.5 percent. A diagram (Figure 3) can be created to provide a better visual understanding of the main contributing sources.

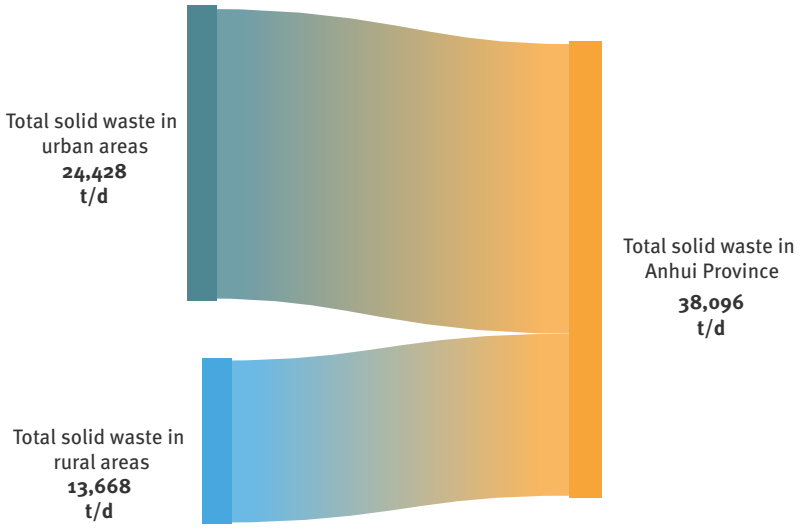
Table 8. Calculation factors for solid waste and plastic waste generation in Anhui Province (2019). **Source:** Anhui Provincial Department of Housing and Urban-Rural Development (2020), National Bureau of Statistics of China (2020).

Parameter	Unit	Urban	Rural
Waste generation gate	kg/person/day	0.55	0.43
CII waste	%	25%	13%
Plastic fraction of MSW	%	16%	14%
Estimated reduction of uncollected plastics through separation efforts	%	6.5%	2%

Table 9. Calculation of total collected and uncollected waste and plastic waste in Anhui Province. **Source:** Kaza et al. (2018).

Parameter	Unit	Urban	Rural	Total
Population	million people	35.53	28.13	63.66
Household waste generation	tonnes/day	19,542	12,096	31,638
Commercial waste generation	tonnes/day	4,886	1,572	6,458
Total waste generation	tonnes/day	24,428	13,668	38,096
Total plastic waste generation	tonnes/day	3,908	1,914	5,822
Average waste service coverage	%	94%	20%	67.5%
Total uncollected waste	tonnes/day	1,465	10,934	12,399
Total uncollected plastics	tonnes/day	234.4	1,531	1,765

Figure 3. Total waste generation. **Source:** Created by authors.



2.5. Management of plastics

When the total amount of plastic waste generated is established, it is important to understand what kinds of plastics are thrown away (i.e. what is considered recyclable and non-recyclable), and what kinds of plastic reduction efforts exist and how much is reduced. Plastic waste reduction efforts can come from initiatives led by the Government, individuals, businesses, institutions, etc. The initiatives can happen at any level (municipal, regional, provincial, basin-wide).

Agricultural film and transferring packing bags used in the postal system were selected as representatives for analysis. In 2018, the National Development and Reform Commission (NDRC) issued the "Guiding opinions on accelerating the control of agricultural non-point source pollution in the YREB", promoting the recycling of plastic mulching films. Under the promotion of the Wuhu Bureau of Agriculture and Rural Affairs, the recovery rate of agricultural film in Wuhu reached 80.4 percent (Wuhu Bureau of Agriculture and Rural Affairs, 2020). In postal transportation, packages to the same destination are placed in the same transferring packing bag, which is conducive to the transfer and loading of the packages. Traditional disposable bags made of woven plastic create large amounts of waste plastic. The State Post Bureau of the People's Republic of China has also adopted circulating transit bags instead of disposable woven bags, saving 2.48 billion disposable woven bags annually and reducing the total usage by 96.4 percent (Development & Research Center of the State Post Bureau, 2020) (Table 10).

Table 10. Plastic waste reduction/recovery efforts (2019). **Source:** Development & Research Center of the State Post Bureau (2020), Wuhu Bureau of Agriculture and Rural Affairs (2020).

Government/individual/ business/institution	Reduction effort	Amount reduced	Reduction/recovery rate
Wuhu Bureau of Agriculture and Rural Affairs	Recycling of agricultural film	2,561.02 tonnes/year	80.5%
State Post Bureau of the People's Republic of China	Elimination of plastic woven bags	24.8 billion items/year	96.4%

Bridge across the Yangtze in Wuhan, Hubei, China.
Source: Willem Chan.

With the values included in the previous sections, a summary of unmanaged plastics can be created (Table 11). The estimated reduction of uncollected plastics is calculated according to the calculation factors in Table 8. Due to effective waste separation, the reduction of plastic waste in urban and rural areas is 15.24 tonnes/day and 30.62 tonnes/day respectively.

Table 11. Summary of unmanaged plastic waste (2019).

Parameter	Unit	Urban	Rural	Total
Total plastic waste generation	tonnes/day	3,908	1,914	5,822
Total uncollected plastics	tonnes/day	234.4	1,531	1,765
Estimated reduction of uncollected plastics	tonnes/day	15.24	30.62	45.86
Total unmanaged plastics	tonnes/day	219.2	1,500	1,719
Proportion of unmanaged plastics to total plastics	%	5.6%	78.4%	29.5%

2.6. Waste flow diagrams

Based on the above analyses, 70 percent of the total plastics were managed and 30 percent were unmanaged. According to the World Wide Fund for Nature (2020), 30 percent of the managed solid waste was recycled, 42 percent was disposed in landfill, and 28 percent was disposed by incineration (Table 12). For the unmanaged waste, 7 percent was estimated to be in the water ecosystem (finally to sea), 50 percent was left on land (outside waste management sites), and 40 percent was burned. Calculations show that 2 percent of plastic ends up in the ocean (Table 13).

Table 12. Summary of managed plastics (2019). **Source:** Development & Research Center of the State Post Bureau (2020), National Bureau of Statistics of China (2020).

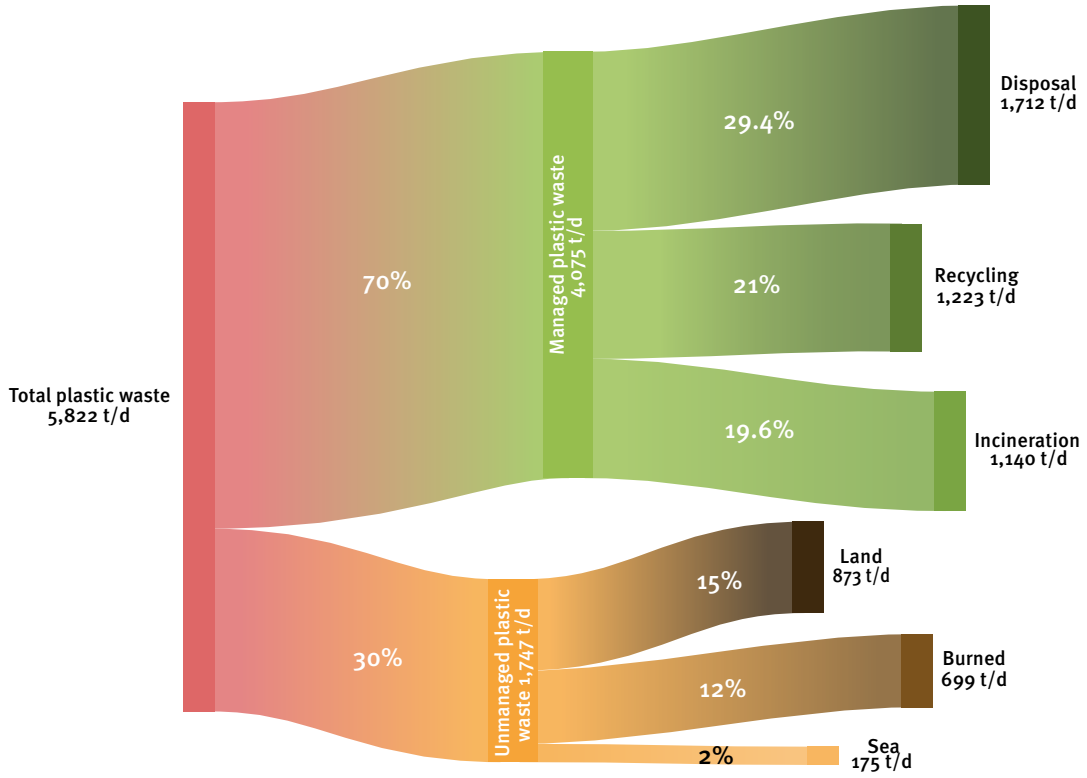
Group	Proportion of managed plastics	Proportion of total plastics
Recycled	30%	21%
Landfill	42%	29.4%
Incineration	28%	19.6%

Table 13. Summary of unmanaged plastics (2019). **Source:** Development & Research Center of the State Post Bureau (2020), National Bureau of Statistics of China (2020).

Group	Proportion of unmanaged plastics	Proportion of total plastics
Sea	7%	2%
Land	50%	15%
Burned	40%	12%

Based on these calculations, the estimated figure for MFA in Anhui Province is that about 175 tonnes of plastics end up in the Yangtze, and ultimately in the ocean, every day (Figure 4).

Figure 4. Plastics material flow analysis result.



Container ship on the Yangtze River in, Yichang, Hubei, China. **Source:** Leon Huang.

3. Institutional analysis of the management and control policy system

This section analyses the current problems in the management of plastic waste and microplastics in China from policy, regulatory, and institutional perspectives.

While noting the great progress that has been made to develop various policy and corporate social responsibility (CSR) measures, we however note key underlying institutional gaps that still exist within the current governance structure.

3.1. Overview of China's policies and measures on plastic pollution control

Since the end of the last century, the Chinese Government has gradually begun to realise the seriousness of plastic pollution, and started to improve management and legislation in this area (Table 14). In 1995, China promulgated the Prevention and Control of Solid Waste Pollution Law of the People's Republic of China . Since then, various ministries and local governments have issued a series of normative documents, established national and industry standards, gradually improved the legal system for the prevention and control of waste plastics, and put forward the principles of "reduction, harmlessness, and resource recovery", as well as whole-process management and classification management of solid waste. Many laws, such as the Marine Environment Protection Law of the People's Republic of China, the Cleaner Production Promotion Law of the People's Republic of China, and the Circular Economy Promotion Law of the People's Republic of China, have provisions concerning the reduction and recycling of solid waste. What follows is an overview of administrative regulations and departmental rules specifically for control of the **production, use, recycling, disposal, and treatment of waste plastics.**

Production of plastic products

In 2001, the State Economic and Trade Commission of the People's Republic of China issued the "Urgent notice on the immediate cessation of the production of disposable foam tableware". In 2007, the General Office of the State Council issued the "Notice on restricting the production and sale of plastic shopping bags" (referred to below as the Plastic Restriction Order), prohibiting the production, sale, and use of plastic shopping bags with a thickness of less than 0.025 mm nationwide. At the same time, a paid use system for plastic shopping bags was implemented. After the ban came into effect, in 2015 the annual use of plastic shopping bags in major retail stores across China decreased by two thirds compared with 2010, which has had a significant impact in saving energy and resources, protecting the environment, and actively tackling global climate change.

Use of plastic products

In 2016, the State Post Bureau of the People's Republic of China issued the "Implementation plan of promoting green packaging in the express delivery industry" to promote the reduction of packaging and reduce environmental pollution. In 2019, the NDRC revised and issued the Guiding Catalogue for Industrial Structure Adjustment, eliminating disposable foam plastic tableware, disposable plastic cotton swabs, daily chemical products containing plastic beads, ultra-thin plastic bags, ultra-thin polyethylene agricultural mulch, and other plastic products. In April 2020, the NDRC together with other relevant

departments organised the drafting of the Catalogue of Plastic Products Prohibited or Restricted in Production, Sale, and Use (Draft for Comments), which detailed the policy boundaries and implementation standards for the production, sale, and use of plastic products in various fields.

Table 14. Current regulations on plastic pollution control in China.

Year	Regulations	Main content
2001	"Urgent notice on the immediate cessation of the production of disposable foam tableware", issued by the State Economic and Trade Commission	Manufacturers shall immediately stop production of disposable foamed plastic tableware, strengthen the supervision and inspection of manufacturers of disposable foamed plastic tableware, promote the production and supply of substitute products, and ensure the smooth completion of substitution.
2007	"Notice on restricting the production and sale of plastic shopping bags", issued by the General Office of the State Council	It is forbidden to produce, sell, and use plastic shopping bags with a thickness of less than 0.025 mm, and payment shall be made for the use of plastic bags.
2007	"Technical regulations for waste plastics recycling and pollution control", issued by the State Environmental Protection Administration	Regulations and requirements for pollution control during waste plastics recycling, storage, transportation, pre-treatment, and re-use, and environmental supervision and management.
2012	"Regulations on waste plastics processing pollution control", issued by the Ministry of Ecology and Environment, the NDRC, and the Ministry of Commerce	Dispose of residual waste produced during waste plastic processing and filter meshes in an environmental-friendly way. It is forbidden to dispose of them through a company or individual that does not meet environmental requirements, and to open-burn waste plastics, residual waste, and filters produced during processing. The waste plastic processing centre shall be provided with a mechanism for recycling and disposing residual waste and filters produced by waste plastics processing companies.
2013	"Notice on deepening implementation of limiting the production, sale, and use of plastic shopping bags", issued by the General Office of the State Council	Enhance publicity efforts, and build an atmosphere of green consumption. Strengthen law enforcement, and carry out supervision and inspection from all aspects. Modify relevant regulations and improve the corresponding policy guarantee systems.
2016	"Implementation plan of promoting green packaging in the express delivery industry", issued by the State Post Bureau of the People's Republic of China	Focus on five major tasks concerning packaging in the express delivery industry: promote law-based management, accelerate green development, encourage minimisation of plastics use, explore the use of recycled products, and implement the pilot green packaging programme. Integrate the five tasks into strengthening daily supervision over packaging in the express delivery industry, and developing and modifying national packaging standards and industrial standards of the express delivery industry.
2017	"Action plan of agricultural mulch recycling", issued by the Ministry of Agriculture	Promote minimum mulching, standardised production, mechanised collection, and specialised recovery of plastic films.

Year	Regulations	Main content
2017	"Implementation plan for the reform of solid waste import management system by forbidding imported waste", issued by the General Office of the State Council	Improve the recovery rate of domestic solid waste; regulate the development of the domestic solid waste processing and utilisation industry; strengthen publicity and guidance; and define the princi-pal responsibility of enterprises.
2017	"Implementation plan of the household waste classification system", issued by the General Office of the State Council	Compulsorily implement household waste classification as per the types of harmful waste, perishable waste, and recyclable waste in some regions, to make residents volunteer to classify waste and enhance the building of a household waste classification support system.
2019	Guiding Catalogue for Industrial Structure Adjustment, issued by the NDRC	Eliminate disposable foam plastic tableware, disposable plastic cotton swabs, daily chemical products containing plastic beads, ultrathin plastic bags with a thickness of less than 0.025 mm, and polyethylene agricultural mulches with a thickness of less than 0.01 mm.
2020	Prevention and Control of Environmental Pollution by Solid Waste Law of the People's Republic of China	Competent departments of the environment shall conduct unified supervision and management of the prevention and control of environmental pollution from solid waste, and other competent departments of the plastic-related industry shall be responsible for the supervision and management of the prevention and control of environmental pollution from solid waste within their respective functions and responsibilities.
2020	"Opinions on further strengthen-ing the control of plastic pollution", issued by the NDRC and the Ministry of Ecology and Environment	Forbid and limit the production, sale, and use of some plastics in an orderly way; regulate plastic waste recycling; establish and improve regulations and standards; improve relevant support policy; strengthen research on mechanisms, monitoring, prevention technology, and policy on plastic waste and microplastic pollution.
2020	"Notice on solidly advancing the treatment of plastic pollution", issued by nine departments including the NDRC and the Ministry of Ecology and Environment	Implement the responsibility in places within jurisdiction; forbid or limit the use of ultra-thin plastic shopping bags and ultra-thin plastic film for agricultural use; standardise the use of plastic shopping bags in markets; promote the classification, recycling, and disposal of plastic waste; and clarify the management responsibilities of each department.
2020	"Measures for the management of agricultural film", issued by the Ministry of Ecology and Environment, and the State Administration for Market Regulation	Clarify the production, sale, use, recovery, and reuse of agricultural film, and its supervision and management methods.
2020	"Green packaging specification for express mail", issued by the State Post Bureau of the People's Republic of China	Ensure standardised, minimum, and recyclable express green packaging, and strengthen coordination with upstream and downstream departments.

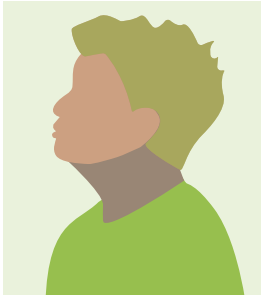
Waste plastic generation and recycling process

In 2017, the General Office of the State Council enacted the "Implementation plan for the reform of solid waste import management system by forbidding imported waste" and the "Implementation plan of the household waste classification system", aiming to promote the implementation of domestic waste classification, and accelerate the establishment of a waste disposal system consisting of classified placement, classified collection, classified transportation, and classified processing. In 2017, the Ministry of Agriculture issued the "Action plan of agricultural mulch recycling", proposing to strengthen the control of agricultural film pollution and improve the resource utilisation of waste agricultural film.

Process of terminal treatment of waste plastics

In 2007, the State Environmental Protection Administration promulgated the "Technical regulations for waste plastics recycling and pollution control". It specifies the requirements for the supervision and management of pollution control and environmental protection during the recycling, storage, transportation, pre-treatment, and recycling of waste plastics. In 2012, the Ministry of Environmental Protection, the NDRC, and the Ministry of Commerce jointly issued the "Regulations on waste plastics processing pollution control". In January 2020, the NDRC and the Ministry of Ecology and Environment jointly issued the "Opinions on further strengthening the control of plastic pollution", which proposed control measures for the whole process and every link of the production, circulation, use, recycling, and disposal processes of plastic products, reflecting the systematic and holistic management of the whole life cycle of plastic products. All departments of the State Council and local governments acted swiftly to make deployments and arrangements. In July 2020, nine government departments, including the NDRC, the Ministry of Ecology and Environment, the Ministry of Industry and Information Technology, and the Ministry of Housing and Urban-Rural Development jointly issued the "Notice on Promoting the Treatment of Plastic Pollution, and formulated the detailed management standard about the plastic product prohibition and restriction. The revised Prevention and Control of Solid Waste Pollution Law of the People's Republic of China, led by the Ministry of Ecology and Environment, came into effect on 1 September 2020. It makes clear the supervisory and administrative responsibilities of the departments concerned under the State Council and local people's governments at various levels for the prevention and control of environmental pollution from solid waste, defines the legal responsibilities of the main body related to plastic pollution control, and sets specific penalties for violations of laws and regulations, thus providing a legal guarantee for plastic pollution control. The State Administration for Market Regulation has included obsolete products such as ultra-thin plastic shopping bags in its annual law enforcement inspections, and taken the lead in improving standards in key areas such as biodegradable plastic products, green packaging for express delivery, and limiting the excessive packaging of goods. The Ministry of Agriculture and Rural Affairs and other departments issued the "Measures for the management of agricultural film", which detailed the requirements for the management of agricultural film production, sale, use, recycling, and so on. The Ministry of Commerce introduced detailed measures to promote the treatment of plastic pollution in the areas of commodity retailing and e-commerce. The State Post Bureau issued the "Green packaging specifications for express mail" and "Measures for the management of express mail packaging".

The above policies and measures provide institutional guarantee at the national level for the establishment of a long-term mechanism to control plastic pollution. Local governments, meanwhile, are likewise stepping up their efforts. So far, 32 provinces and municipalities have issued specific opinions and plans on further strengthening the treatment of plastic pollution.



3.2. Corporate action and bottom-up initiatives towards plastic waste pollution control

In addition to government policy measures, enterprises, non-governmental organisations (NGOs), and civil society are also playing important roles in plastic waste pollution control from the bottom up. CSR has an important impact on the research and development, sale, and the whole life cycle of plastic products. Studies reveal that CSR projects focusing on environmental sustainability, particularly water, increased between 2006 and 2016 (Li, Khalili, and Cheng, 2019). Enterprises play an essential role in plastic pollution reduction through changing and adopting eco-friendly business practices, forging partnerships with the host governments and other stakeholders, investing in research and technological innovations, and the provision of both technical and financial resources for relevant projects (Garcia, Fang, and Lin, 2019).

CSR

Coverstro and Coca-Cola are two examples of the companies with notable CSR measures specifically targeting the reduction of plastic waste and pollution in the YREB. **Covestro** have been engaged in education and awareness programmes focusing on children. To advance their efforts, they have launched a book promoting ocean protection and reduction of marine litter, entitled Brighter Minds for a Brighter Future, and a storytelling app in both English and Chinese languages (Alliance to End Plastic Waste, 2020a). Covestro is closely working with local bottled water and beverage company Nongfu Spring, and plastics recycling company Ausell, to collect and recycle over 1 million polycarbonate barrels per year, which are then transformed into recycled plastics for the automotive, electronics, and home appliances industries.

CSR

Coca-Cola China actively responds to the Government's calls to build a "green China" and a "waste-free city", and works with public welfare organisations and social enterprises to explore methods of effective recycling, recycled material utilisation, and public education. In 2013, Coca-Cola and the Yangtze River Delta Circular Economy of Technology will form a partnership to research and develop a way to use agricultural waste to produce Coke's plastic bottles. the Coca-Cola Company aims to use this PlantBottle technology for all its plastic bottles in China, greatly reducing its negative environmental impact (Bureau of Public Affairs, 2013). In 2020, Coca-Cola China joined forces with JD.com, a Chinese e-commerce company, to promote plastic bottle recycling from households through their logistics supply chain, in order to explore the possibilities of the circular economy while promoting responsible consumption and sustainable lifestyles. Recently, the company launched its first WeCare Bag made from recycled bottles, in an effort to explore the new circular economy model and advocate responsible consumption. This initiative is part of the beverage giant's plan to achieve its goal of "helping collect and recycle the equivalent of 100 percent of its packaging by 2030" (Zhuoqiong, 2020).

NGO

NGOs are also influential actors in plastic pollution control. For example, the **Alliance to End Plastic Waste (ATEPW)** is an international non-profit organisation that works with governments, environmental and economic development NGOs, and communities around the world to address the challenge of eliminating plastic waste from the environment (ATEPW, 2020b). Through projects and partnerships, ATEPW focuses on solutions in four strategic areas: infrastructure, innovation, educational inclusion, and clean-up. The first two Chinese alliance members are Sinopec, a state-owned enterprise in the petroleum and chemical industry, and the Shanghai-based global material manufacturing and service provider Red Avenue New Materials Group Co., Ltd. In 2020, ATEPW announced a strategic partnership with the China Petroleum and Chemical Industry Federation (CPCIF) and their joint efforts for plastic waste reduction. This public-private partnership is a very significant step forward for China, as it brings together the CPCIF partner stakeholders, including the local governments, and ATEPW's 47 leading global member companies to collaborate in unlocking global capital investments, bringing forth technical expertise necessary to make a positive contribution in China's plastic pollution challenge, and implementing locally led plastic pollution solutions. In addition, ATEPW partnered with an early-stage startup accelerator, Plug and Play China, which has an End Plastic Waste Innovation Platform. This innovation-motivated partnership aims to encourage inspiring startup enterprises to research and develop technologically advanced plastic waste solutions that can be implemented locally (ATEPW, 2020c).

NGO

The **Shanghai Rendu Ocean NPO Development Center**, a Shanghai-based environmental NGO, has also been active in organising marine environmental protection actions and promoting public awareness of marine conservation, including on the issue of plastic pollution. In 2007, they organised their first "International Coastal Cleanup", which led to the "Love the Source of My Life" coastal clean-up project (China Development Brief, no date). In 2014, they additionally established the Coastal Waste Civilian Monitoring Project, in collaboration with the Shenzhen Mangrove Wetlands Conservation Foundation and partners in 12 coastal cities. Along with their clean-up programmes, the NGO is active in monitoring coastline pollution, and produces research papers

for the public. Some of their projects are done in collaboration with research institutions and government departments to promote policy development and problem solving on marine waste management.

3.3. Institutional and regulatory gap analysis

While China has made great progress in terms of plastic waste management policies and management systems, several gaps can still be found in the institutional structure currently in place.

Legal coherence

China has issued several national level regulations for the management of plastics which sometimes overlap, resulting in a lack of clarity. Relevant regulations and standards are in fact scattered across several laws, normative documents, and standards. Some laws and regulations are too general, punitive measures are not clear, and the law is not sufficiently rigid, resulting in a lack of a strong grip on plastic pollution control. For example, the Plastic Restriction Order of 2007 was originally intended to regulate plastic consumption through economic means, but after a period of adjustment, consumers adapted to the paid use of shopping bags, and the Plastic Restriction Order became a “plastic purchase order”. In addition, in small farmers’ markets and in rural areas, merchants still offer free plastic shopping bags due to a lack of effective supervision, which has greatly reduced the effectivenvess of the ban.

Regulatory enforcement

Plastic pollution has the characteristics of complex formation mechanisms and multiple control scenarios. The current measures to control plastic waste pollution are essentially reduction at the source and process management, and the full life cycle control of plastics is realised through production and consumption reduction, disposal process management, and recycling. However, most of these measures focus on the production, consumption, and recycling of plastic products, and the prevention and control of the entry of plastic pollution from land sources into rivers, and the treatment of plastic pollution in water bodies, are insufficient. For example, in 2020, the “Notice on solidly advancing the treatment of plastic pollution” jointly issued by the nine ministries and commissions did not include the responsibilities of water conservancy departments in plastic pollution control. As a result, blind spots still exist in terms of plastic pollution in river management.

Departmental cooperation

The prevention and control of plastic pollution involves multiple links, such as production, circulation, consumption, recycling, and disposal, and each link is managed by multiple departments. The Prevention and Control of Solid Waste Pollution Law of the People's Republic of China stipulates that the Ministry of Ecology and Environment shall implement unified supervision and management of the prevention and control of environmental pollution by solid waste. However, other authorities, such as the NDRC, the Ministry of Industry and Information Technology, the Ministry of Natural Resources, the Ministry of Housing and Urban-Rural Development, the Ministry of Water Resources, the Ministry of Agriculture and Rural Affairs, and the Ministry of Commerce, also have the responsibility of monitoring and managing environmental pollution caused by solid waste. The "Opinions on further strengthening the control of plastic pollution" has only recently been introduced, and there remain problems in implementation, such as ambiguous policy goals, conflicts of interest between departments, unclear functional division, and poor coordination. As a result, there are many problems in plastic waste management, such as multiple management, unclear rights and responsibilities, buck-passing, and waste of resources, which lead to difficulties in the closed-loop management of the whole life cycle of plastic products.

Regional coordination

The cross-regional characteristics of plastic waste pollution are significant. Because of the fluidity of water, plastic pollutants in water bodies tend to drift downstream and downwind, so the responsibility for cleaning up can easily shift. However, the current policy system still makes it clear that the prevention and control of plastic pollution is based on territorial management, and there is no institutional arrangement to carry out plastic pollution control based on watershed. Due to differences in economic and technological levels between regions, the understandings and implementations of plastic pollution prevention and control policies by local governments are often inconsistent. There is a lack of coordination and cooperation in joint plastic pollution control, joint monitoring, joint law enforcement, ecological compensation, and so on, showing the characteristics of fragmentary governance, and resulting in a vicious circle from the attitude that upstream pollution can be treated downstream.

Wuhan Yangtze River Bridge, Wuhan, Hubei, China.
Source: White Rainforest.

Monitoring and evaluation

Problems with the collection of data and information still exist. Firstly, the monitoring of plastic waste in China started late, the basic data about plastic pollution is insufficient, the flux of plastic waste into rivers is unknown, and the main sources of pollution are not clear. All this constrains the development of measures to control plastic waste and microplastics. Secondly, plastic waste in river systems involves transboundary pollution, and there is too little transboundary monitoring and insufficient monitoring capacity for (micro-) plastic indicators. Thirdly, technical specifications and standards concerning river plastic pollution have not been issued at the national/watershed level, and the detection and monitoring standards, technologies, and indicators of plastic waste and microplastics have not been unified among different regions and departments, resulting in informational barriers to monitoring data and resource waste. Fourthly, the (micro-) plastic pollution index is not included in the RCS assessment system, wastewater management list, or ecological compensation basis, resulting in the lack of an effective guarantee for the supervision and assessment of plastic pollution, and the implementation of responsibility.

Corporate engagement and public participation

Today's plastic pollution problems necessitate concerted efforts of the Government, the private sector, and civil society. However, few positive partnerships between these actors yet exist. The role of governments in supporting CSR has not been fully exploited. The current plastic pollution management regulations and government decisions fail to acknowledge the governance potential of corporate sector involvement. In addition, there are no effective economic incentives or regulatory measures to encourage more companies to fulfil their social responsibility for plastic pollution prevention and control. Corporate and stakeholder awareness and capacity building on CSR is generally weak. A government-guided, responsible enterprise, and participatory system for the prevention and control of plastic pollution has not yet been formed.

4. The River Chief System

The RCS is an organisational structure that was introduced in the early 2000s as an experiment to support the protection and environmental management of rivers and lakes in China.

In this section, we present how the RCS system functions and how it has so far been applied, using Lake Taihu and the Chishui River basin as two illustrative case studies. We then proceed with a critical analysis of the RCS, and examine how it could be further applied to overcome some of the key institutional gaps hitherto noted in regard to plastic pollution monitoring and control.

4.1. The origin of RCS

RCS was first implemented in 2003 in Changxing County, Zhejiang Province, where it was proposed as a new way of solving the water pollution problems in urban rivers. After the cyanobacteria outbreak in Lake Taihu in 2007, the local government of Wuxi, Jiangsu Province, further experimented and developed the RCS by nominating the head officials in charge of the government to be "river chiefs" responsible for 64 major rivers. Remarkable improvements in water quality were achieved in a short period, bringing RCS to the attention of other provinces. In 2016, the central Government released the document "Opinions on full implementation of the River Chief System across the country", marking the start of a rapid transition of the RCS from a localised emergent policy experiment to nationwide action. By 2021, there were more than 1.2 million river chiefs in China (Biswas and Tortajada, 2021).

The RCS relies on a five-level organisational structure of river chiefs: provincial, municipal, county, township, and village. River chiefs at different levels are assigned to take responsibilities for the management and protection of rivers and lakes in their jurisdictions. Their "six main tasks" include strengthening water resource protection, river and lake shoreline management and protection, water pollution prevention, water environment governance, water ecology restoration, and law enforcement and supervision. River chiefs receive assistance and support from the Office of the River Chief System (ORCS), which is responsible for organising and implementing the specific affairs of the RCS, and coordinating the cross-sectoral problems in their jurisdictions. Since the expansion of the RCS nationwide in 2016, the condition of rivers and lakes in China has continued to improve significantly, proving the effectivity of the RCS for solving complex collaborative problems in water pollution control.

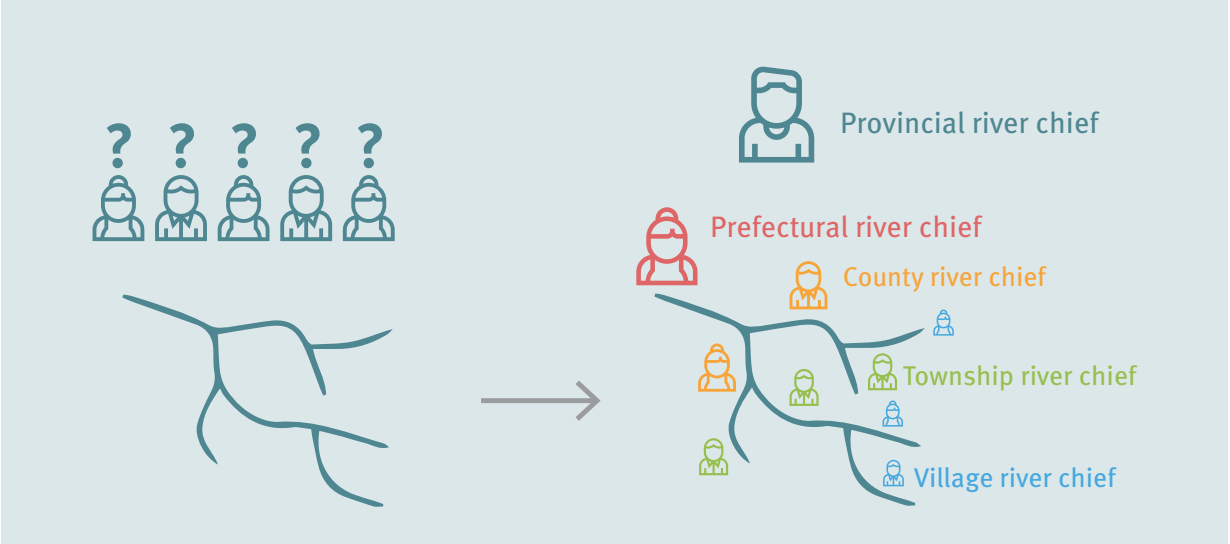
4.2. The basic characteristics of the RCS

The RCS presents several characteristics, which if properly applied, could provide enhanced coordination for plastic pollution monitoring and control.

Multi-level coordination

The RCS is aligned with the basin-wide Source-to-Sea (S2S) management approach (Mathews et al., 2019; Stockholm International Water Institute, 2021). The river is divided into parts with chiefs responsible for each segment, but the river is managed as a whole interconnected system rather than isolated hydrographic entities (Figure 5). For rivers within one province, the RCS can use the authority of the higher-level Government to break the administrative barriers, and implement the management and protection tasks in a coordinated way through the RCS responsibility chain at provincial, municipal, county, township, and even village

Figure 5. The River Chief System mechanism. **Source:** Xu (2017).

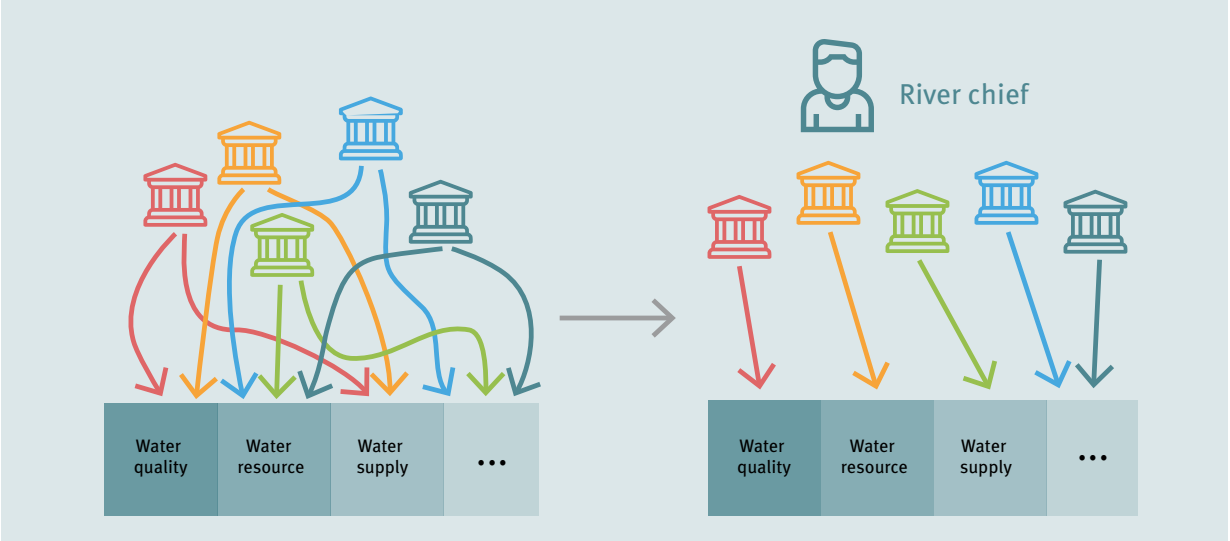


levels. For trans-provincial rivers (for instance the Yangtze River, which crosses 11 provinces), the RCS can further assist watershed management agencies by providing guidance, coordination, supervision, and monitoring roles. It can help establish the trans-provincial river environmental pollution collaboration mechanism with provincial ORCS, to overcome the fragmentation of management between upstream and downstream areas, and achieve trans-provincial coordination and synchronisation of environmental pollution management measures, thus promoting the holistic management of the whole basin from the source to the sea.

Cross-sectoral collaboration

The RCS provides a platform for cross-department cooperation. Under the leadership of a river chief, multiple departments from the source to the sea are more easily coordinated and integrated in information sharing, "one river, one solution" development, and implementation, increasing the efficiency of water resource management and environmental protection (Figure 6).

Figure 6. The river chief as a coordinator of different departments. **Source:** Xu (2017).



Participatory

The RCS actively encourages enterprises, social organisations, the public, and other stakeholders to participate in river and lake protection, management, and supervision. In recent years, groups of "enterprise river chiefs" and "civil river chiefs" have been selected, a collaborative platform for river protection volunteers has been set up, and special training and exchange of experience in river management and water protection have been organised. In addition, the river chief actively invites enterprise river chiefs, volunteers, and representatives of public welfare organisations to participate in joint meetings of the watershed RCS, to guide and encourage enterprises to actively fulfil their social responsibilities, and jointly create a good social atmosphere to manage and protect water environment.

Context-dependent

Based on the actual situation of different rivers and lakes in different areas, the RCS implements "one river, one solution" by mapping the health of rivers and lakes, scientifically diagnosing the main challenges to rivers and lakes, determining the goals and tasks of river and lake management and protection, and putting forward river and lake management and protection measures according to local conditions to ensure that the measures are effective.

Results-oriented

The RCS views improving the environmental situation from the source to the sea as results-oriented, through the step-by-step development of a river and lake management and protection work implementation plan, sound linkage mechanism, clear assessment system, joint action, etc., to promote collaborative management and protection from the source to the sea.

Adaptive management

The RCS relies on the principle of learning by doing, to carry out a "one river, one solution" programme revision work every three to five years through pragmatic implementation, monitoring, evaluation, and adaptive management. This method allows early detection of progress or impediments in achieving desired outcomes, and allows for effective course correction.

4.3. Illustrative cases of water pollution management in cross-provincial rivers and lakes under the RCS

To further understand how the RCS has been applied in practice, we provide two illustrative case studies from the YREB region, namely vthe joint protection of the Lake Taihu basin and the Chishui River basin.

Lake Taihu

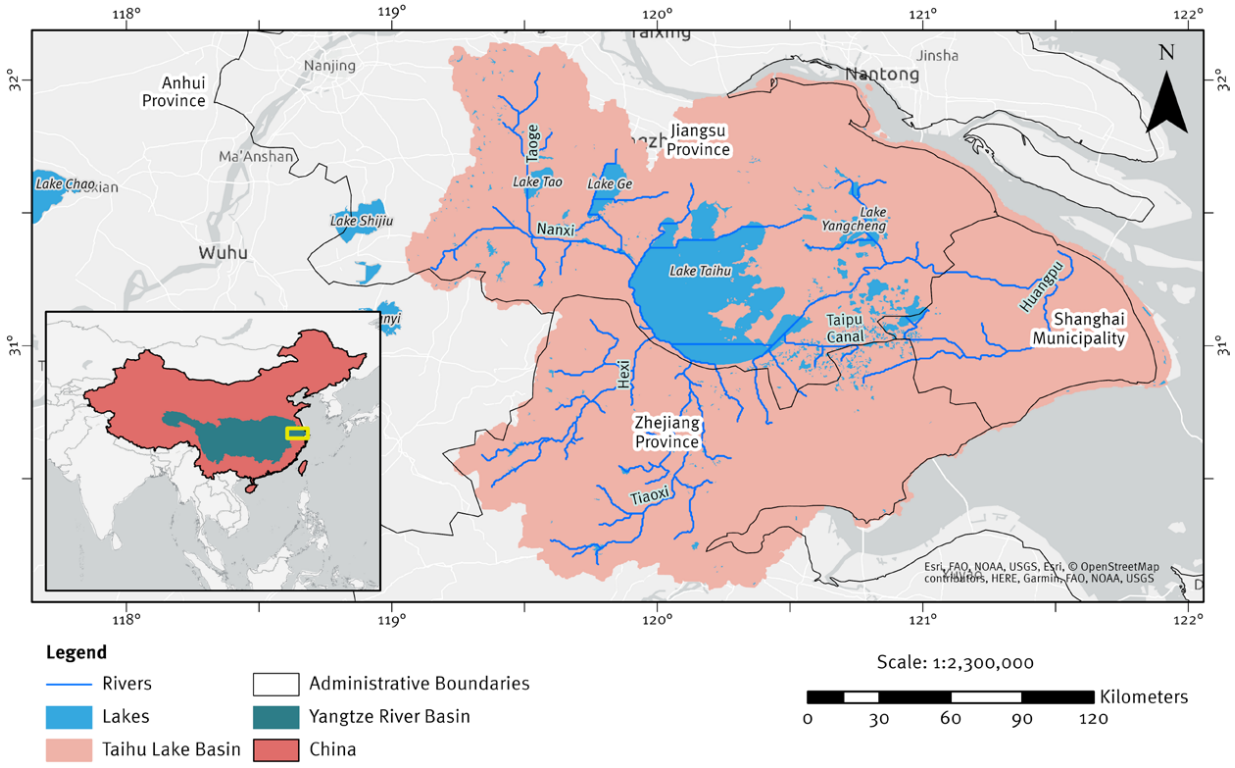
Lake Taihu, the third largest freshwater lake in China, lies in the south of the Yangtze River Delta (Figure 7). It has a watershed area of 36,500 km^2 and flows through Jiangsu, Zhejiang Province, and Shanghai. Lake Taihu is one of the most developed areas in China. It is densely populated, with an urbanisation rate of about 80 percent. As a result, Lake Taihu's water pollution is serious. There are high levels of nitrogen and phosphorus nutrients in the lake, and cyanobacterial blooms happen frequently. There are prominent conflicts between social and economic development and the supply of water resources, water environment improvement, and water ecology protection; it is difficult to achieve the comprehensive and coordinated management of the basin with these different demands.

To enable the coordinated treatment of water pollution problems in the Lake Taihu basin, the following work has been carried out in the Lake Taihu basin under the organisational framework of the RCS.

Establishing a Joint River Chief Responsibility System

Wujiang District of Suzhou actively cooperates with Qingpu District of Shanghai, Jiashan County, and Xiuzhou District of Jiaxing City. They broke the barriers of administrative areas to establish a Joint River Chief Responsibility System, and set up a new model for cross-province joint water treatment. The range of activity of 315 "joint river chiefs" covers all rivers and lakes at the junctions of peripheral districts and counties. They have established five mechanisms, namely joint river patrols, joint cleaning, joint monitoring, joint law enforcement, and joint governance. In this way, a sound and integrated regional river and lake treatment system has been formed, a win-win situation for regional ecological governance.

Figure 7. Lake Taihu basin. **Source:** Lehner and Grill (2013); Messager et al. (2016); OCHA (2020); Esri (2022).



Many joint river and lake treatment projects have been implemented based on the Joint River Chief Responsibility System. In 2018, Wujiang District and Xiuzhou District contributed jointly for desilting and dredging of the Qingxi River. In 2020, Wujiang District and Qingpu District invested jointly and finished the joint treatment of the leading segment of Lake Yuandang. On this basis, Qingpu District, Wujiang District, and Jiashan County further expanded the areas of treatment, and confirmed several trans-district joint river and lake treatment projects in the ecological, green, and integrated development demonstration area in the Yangtze River Delta.

Along with the implementation of the trans-district Joint River Chief Responsibility System, the quality and stability of the river and lake ecosystems in Wujiang District have been continuously improved. Among the district-level rivers and lakes, the number of bodies of water with water quality of or higher than level III increased from 24 in 2018 to 76 in 2020. The water quality of two cross-sections subject to the national assessment was better than the annual assessment standard. The case of regional integrated ecological governance through the Joint River Chief Responsibility System in Wujiang District has been successfully included in the list of representative cases 2020 *Collection of Reform Cases in China* as an innovative practice case for local reforms.

Establishing the Lake Chief Coordination Mechanism

The watershed management institution the Taihu Basin Authority, through cooperation with the river chief offices of Jiangsu, Zhejiang, and Shanghai, has jointly established the Lake Taihu-Lake Dianshan Chief Coordination Mechanism. Its major tasks are to strengthen the coordination between the regions along Lake Taihu and between the river and lake chiefs; strengthen the comprehensive treatment, management, and protection of Lake Taihu, the lake inlet, and peripheral land areas; solve the major problems across the regions and departments; and ensure the work under the Lake Taihu-Lake Dianshan Chief Coordination Mechanism can be more effective.

In 2020, under the guidance of the coordination mechanism, various tasks of the Lake Taihu Chief Coordination Mechanism were successfully carried out. Main tasks included revising the joint patrol system for the administrative enforcement of laws on waters in Lake Taihu basin; strengthening sharing of hydrological and water ecology information, water resources, and the aquatic environment in the Lake Taihu basin; strengthening the joint modification of "one lake, one policy" in Lake Taihu basin; and the joint prevention and control of the invasive species of water hyacinths along the provincial boundaries.

Jointly conducting pollution control

The Taihu Basin Authority has issued the Coordination Mechanism for the Prevention and Control of Water Hyacinths Along Provincial Boundaries, and taken the lead to establish a liaison group for water hyacinth prevention and control, by which to strengthen the joint cleaning work in upstream and downstream areas. The Taihu Basin Authority, through combining the Regional Cooperation Office of the Yangtze River Delta and the water resources departments of Shanghai, Jiangsu, and Zhejiang, conducted the monitoring and inspection of water hyacinth prevention and control in key water areas in key rivers and lakes along the provincial boundaries. They also promote joint prevention, management, and treatment of the whole basin through incentive methods, including the establishment of a party member vanguard.

Wuxi of Jiangsu Province and Huzhou of Zhejiang Province signed a cooperation agreement for blue algae prevention and control in Lake Taihu, and established ten mechanisms for integrated planning, project admission, joint conference, joint law enforcement, ecological restoration, information sharing, joint patrols, cross inspections, emergency support, and spreading and application, to improve the level of coordinated prevention and control of blue algae.

Building an information-sharing platform

The Taihu Basin Authority took the lead to set up the information-sharing platform for the comprehensive treatment of the water environment in the Lake Taihu basin. It held a video conference on information sharing of comprehensive treatment of the water environment in the Lake Taihu basin together with the departments of water resources and the environment in Jiangsu, Zhejiang, and Shanghai. It also prepared and issued the “2019 annual paper on information sharing on the water wnvironment in the Lake Taihu basin”, which covered hydrological and water resources, water environment, water ecology, water-related projects, and management of rivers and lakes in the Lake Taihu basin.

Innovating for public involvement

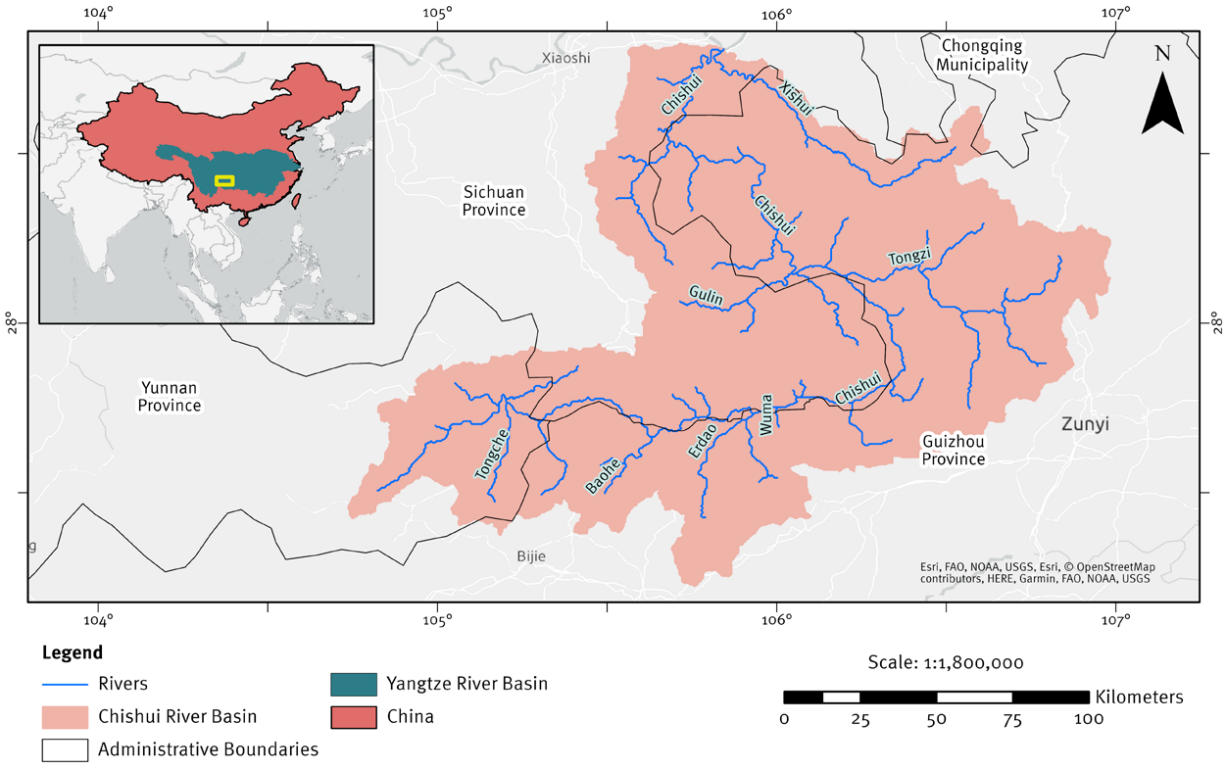
Zhejiang River Chief Office, through cooperation with Alibaba Group, initiated the “Lucid Water Credit” system for water protection by the public, with an aim to strengthen watershed management and stimulate the public to protect rivers and lakes. The public can participate in the management and protection of rivers and lakes through patrolling rivers and finding and solving problems, and can obtain corresponding “lucid water credits”. This has greatly aroused the enthusiasm of the public to participate in water treatment and protection. Meanwhile, it also improves the RCS management platform, and incorporates the issues reported by the public into the assessment of the river and lake chiefs at all levels, thereby encouraging the river and lake chiefs to fully perform their duties and raising their consciousness of responsibility and working efficiently. Following the principles of finding problems, giving credits, offering rewards, and ensuring rewards, more than 600,000 persons have registered at the public water protection platform in Zhejiang. More than 36,000 problems have been identified, and more than 98 percent of those problems have been solved.

Chishui River

The Chishui River is the first grade tributary stream on the upper reaches of the Yangtze River. Its main stream flows through Yunnan, Sichuan, and Guizhou. Located in the Chengdu-Chongqing Economic Circle National Strategic Area, it has a great significance for environmental protection in China. It is also a representative trans-provincial river where the RCS has been implemented.

The Chishui River basin was administrated by the three provinces mentioned above. For a long time, these provinces lacked the necessary coordination and cooperation in resource development and utilisation, environmental protection, and regulatory systems and mechanisms, making it difficult to coordinate comprehensive administration issues at the basin level. Since the implementation of the RCS, however, the three provinces in the Chishui River basin have actively explored the joint administration and protection of rivers and lakes.

Figure 8. Map of the Chishui River basin. **Source:** Lehner and Grill (2013); Messager et al. (2016); OCHA (2020); Esri (2022).



Joint formulation of policies and regulations for the protection and administration of the whole river basin

In order to strengthen the protection of the Chishui River basin, regulate development, utilisation and administration activities, and improve the environment, the three provinces in the basin have promulgated "Regulations on the protection of the Chishui River basin in Guizhou Province" (2011), "Regulations on the protection of the Chishui River basin in Yunnan Province" (2021), and "Regulations on the protection of the Chishui River basin in Sichuan Province" (2021). In addition, the Standing Committees of the People's Congress of the three provinces jointly studied and formulated a "Decision on strengthening the joint protection of the Chishui River basin" (2021), creating an innovative form of local joint legislation with regulations and joint decisions, providing a strong legal guarantee for the protection and administration of the Chishui River basin.

Joint prevention and control coordination mechanisms at provincial, municipal, and township levels

At the provincial level, the river chief offices of Sichuan, Yunnan, and Guizhou jointly signed the Joint Agreement on Environmental Protection in the Chishui River Basin to promote environmental protection in the Chishui River basin and strengthen the administration of boundary waters. In recent years, Sichuan, Guizhou, and Yunnan have carried out joint law enforcement on several occasions, discovering and correcting more than 150 environmental problems.

At the municipal level, in October 2020, the river chief offices of Zunyi City and Luzhou City carried out a series of themed activities on deepening regional cooperation and jointly protecting the Chishui River, and signed the Cooperation Agreement on Joint Prevention and Control of Cross-border Rivers.

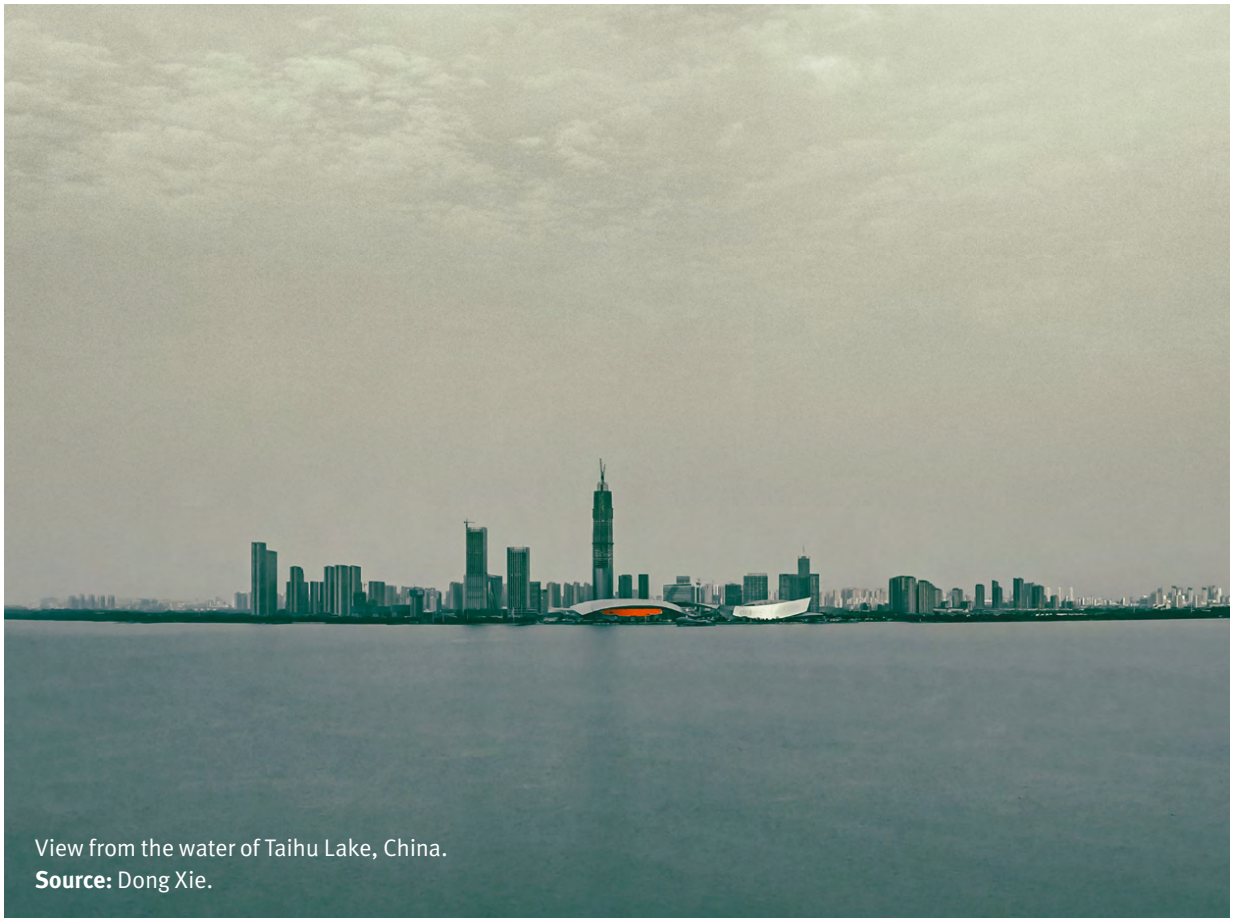
At the township level, in 2020, Chishui City and Luzhou City, Chishui City and Xishui County, and Xishui County and Renhuai City established working mechanisms of exchanging deputy river chiefs for the Chishui River, strengthening horizontal linkages, sharing information, timely communications, mutual supervision and work exchanges between river chiefs at the township level, and focusing on solving the problem of cross-regional river rectification efficiency. In 2017, 16 counties (cities or districts) from the three provinces of the Chishui River basin formulated and adopted the Renhuai Declaration to jointly promote environmental protection. In 2019, Chishui River Chief Office and Luzhou River Chief Office signed the Cross-border Cooperation Agreement on the River Chief System between Hejiang County and Chishui City. In 2020, the Cooperation Agreement on Joint Prevention and Control of Cross-border Rivers (Sections) was signed.

Establishment of the Joint Law Enforcement Mechanism of River Chief, Police Chief, and Chief Procurator

In the Chishui River basin, mechanisms like the Joint Law Enforcement Mechanism of River Chief, Police Chief, and Chief Procurator have been established. The police, procuratorate, and judicial departments serve as liaison units for river and lake chiefs at the provincial level, and jointly undertake the overall planning, organisation, coordination, supervision, and assessment of the river and lake chief system, to strengthen law enforcement forces for illegal acts involving rivers and lakes.

Focus on social awareness and public participation

Since 2017, the three provinces in the river basin have appointed primary or secondary school principals as honorary river chiefs, and set up educational columns and theme parks for the RCS through campus radio and school newspapers, so that teachers and students can further understand the RCS and the protection of rivers and lakes.



View from the water of Taihu Lake, China.
Source: Dong Xie.

4.4. The potential of strengthening the RCS as a coordinating mechanism to enhance plastic pollution monitoring and control

As seen in the two case studies, the RCS has obvious institutional advantages in solving water pollution issues. That said, the RCS has yet to be leveraged as a coordinating entity and collaboration platform for dealing with the problem of plastic pollution in the Yangtze. Here are some reasons why we believe the RCS shows great potential to become the anchoring institutional arrangement for enhancing plastic pollution monitoring and control.

The responsibility of RCS in river and lake management has a legal basis recognised at the national level

The Water Pollution Prevention and Control Law of the People's Republic of China, revised in 2017, for the first time put the RCS into national law, calling for "establishment of the River Chief System at the provincial, municipal, county, and township levels to organise and lead the work of water resources protection, water shoreline management, water pollution prevention and control, and water environment management of rivers and lakes within the administrative region". This provision provides an important legal guarantee for the implementation of RCS nationwide. In March 2021, the Yangtze River Protection Law came into force. As the first river basin law in China, it clearly states that "the river and lake chiefs at all levels in the Yangtze River basin are responsible for the work related to the protection of the Yangtze River", which further strengthens the responsibilities of river and lake chiefs in Yangtze River protection.

Six major tasks under the RCS includes plastic pollution control provisions

The "Opinions on the comprehensive implementation of the River Chief System" specifies six tasks of the RCS, including water resources protection, management and protection of river and lake shorelines, water pollution prevention and control, water environment treatment, water ecological restoration, and law enforcement and supervision, which systematically covers the whole process of water pollution treatment and control in river basins, including plastic pollution. For example, in terms of the source control of plastic pollution, it clearly proposes to investigate the sources of pollution into rivers and lakes, strengthen comprehensive prevention and control, and strictly control the pollution from industrial and mining enterprises, urban living pollution, agricultural non-point source pollution, ship and port pollution, etc. In view of the migration process of plastic pollution, it clearly proposes the strengthening of the overall planning for water and shores, to control the problems of littering, dumping, landfilling, and storing and stacking solid waste. The layout of sewage outlets into rivers and lakes should be optimised and the outlets should be improved. As for domestic sewage treatment and garbage treatment, the rural water environment should be comprehensively improved. In view of the terminal disposal process of plastic pollution in water bodies, it clearly proposes to strengthen the comprehensive improvement of the water environment of rivers and lakes; establish and perfect the mechanism of water environment risk assessment, investigation, early warning and forecast, and response; and strengthen the control of black and odorous water bodies. In view of the supervision and enforcement of plastic pollution, it clearly puts forward a series of measures, including the establishment and improvement of regulations and systems related to the management and protection of rivers and lakes, the introduction of joint law enforcement mechanisms between departments, the daily supervision and inspection system of rivers and lakes, and the implementation of dynamic supervision of rivers and lakes. In the tasks under the RCS, the relevant arrangements for water pollution prevention and control, water environment treatment, water shoreline management and protection, and law enforcement and supervision, provide powerful means for the effective implementation of plastic pollution control measures.

The RCS can coordinate basin-wide S2S action

Plastic pollution in rivers has obvious transboundary characteristics. The "Opinions on the comprehensive implementation of the River Chief System" clearly states that "river chiefs at all levels shall clarify their responsibilities for the management of rivers and lakes across their administrative regions, and coordinate the upstream and downstream as well as the left and right banks to implement joint prevention and control". For rivers which fall within one province, the RCS can use the authority of the higher-level Government to break administrative barriers, implement the management and protection tasks in a coordinated way through the river chief responsibility chain at the provincial, municipal, county, township, and even village levels, and promote the holistic treatment of watershed plastic pollution. For interprovincial

rivers, under the "Guidance of the Ministry of Water Resources on further strengthening the performance of duties of river chiefs", the river basin management agencies give full play to their guidance, coordination, supervision, and monitoring roles, establish a communication and consultation mechanism with provincial ORCS, and establish a cross-regional cooperation platform to study and coordinate major issues in the work of RCS. For example, the Changjiang Water Resources Commission issued the River and Lake Chief System Collaboration Mechanism for the Yangtze River Basin in July 2021. Under this collaborative mechanism, the Changjiang Water Resources Commission will work together with the provincial ORCS in the Yangtze River basin to carry out a series of activities, such as regional joint prevention and control, joint consultation, information sharing, collaborative governance, and joint law enforcement, effectively coordinating upstream and downstream, left and right banks, and water and shore management and protection objectives and tasks, replacing the fragmented water management system and making joint efforts to control water pollution.

The RCS can coordinate the forces of multiple departments

The prevention and control of watershed plastic pollution is a complex and systematic project that involves many industries and departments. The RCS, guided by the goal of water management, breaks through the organisational barriers of departments and strengthens horizontal cooperation between departments. It not only clarifies the prominent advantages of the water conservancy and environmental departments, but also stipulates the division of labour and responsibilities of the functional departments of the NDRC, finance, transportation, housing and construction, agriculture, and commerce in the treatment of plastic pollution. On this basis, departmental linkage, information and resource sharing, standardisation, and comprehensive law enforcement can be realised. As far as the central Government is concerned, the interministerial joint conference system for the comprehensive implementation of the RCS, led by the Ministry of Water Resources and composed of 18 relevant ministries and commissions, including the NDRC, the Ministry of Natural Resources, and the Ministry of Ecology and Environment, has been established to promote the coordination of ministries and commissions to solve major problems of river and lake management and protection. As far as the local government is concerned, the communication and coordination mechanism of ORCS has been established, and the working pattern has been formed in which the river chief takes the lead, the ORCS makes overall planning and coordination, and each department assumes its own duties and responsibilities. These measures can change the structure of plastic pollution management to a certain extent, and help realise the systematic management of plastic pollution from the source to the ocean.

The RCS can promote the participation of enterprises

Enterprises are the most important source of plastic pollution, and have the main responsibility in the plastic pollution control link from the source to the sea. In the context of the comprehensive implementation of the RCS, the sound government-led, enterprise-based environmental governance system is particularly important in the process of plastic pollution control. The RCS provides a platform for enterprises to participate in the process of plastic pollution control.

Currently, the Enterprise River Chief System has been actively promoted around China. Through the selection of pollution-related enterprises as the enterprise river chief, to strengthen collaborative participation and enhance the awareness of CSR. On the one hand, under the unified organisation and leadership of the ORCS at a higher level, an "enterprise river chief" could assist a river chief to inspect and supervise the plastic pollution produced by industry, investigate the main sources of pollutants in the river coming from enterprise, and report the relevant information to the river chief in a timely manner, and actively participate in the RCS joint meetings, discuss the treatment plan with the river chief, government departments, and the public, and make suggestions for treatment. On the other hand, through inviting environmental experts to train the enterprise river chiefs, the ORCS exchange governance experience with environmentally friendly enterprises, and encourage enterprises to explore clean production and circular production models to ensure that sewage is discharged in accordance with standards, while popularising the concept and promoting technology to enterprises for reducing plastic waste at source. Thirdly, the river chiefs can assess the implementation of the enterprise river chief, the effectiveness of the management of polluted rivers, and the satisfaction and support of the public, and evaluate the outstanding enterprise river chiefs and "green entrepreneurs" for commendation and reward, to motivate other enterprise river chiefs to conscientiously fulfil their social responsibilities, thus building a government-led, enterprise-based and multi-stakeholder participatory pattern of RCS, urging enterprises to better cooperate with the local government and enhance mutual supervision to jointly manage the problem of plastic pollution from source to sea.

5. Discussion and recommendations on strengthening the control of plastic pollution

in the Yangtze River basin under the RCS

What follows are our key recommendations on how to enhance plastic pollution monitoring and control in the Yangtze, and how to best capitalise on the RCS and turn it into a foundational mechanism for multi-stakeholder coordinated action.

Recommendation 1

Establishing a special coordination mechanism for the control of plastic pollution

The river basin authority assigned by the Ministry of Ecology and Environment and the Ministry of Water Resources should, together with the provincial river chief offices in the basin, establish a special coordination mechanism for the control of plastic pollution in the Yangtze River basin. As required, river chief offices at all levels in the province should prepare a special coordination mechanism for interprovincial plastic pollution control, and support the response to heavy cross-regional plastic pollution in the basin. This coordination mechanism should focus on the main tasks under the RCS, including joint promotion of management and protection of shorelines, and joint removal of plastic waste along the shoreline; further prevention and control of water pollution in the basin, and strengthened investigation of plastic pollution sources into rivers, control of pollution discharge outlets, and prevention and control of pollution from non-point sources; and comprehensive management of water environment, strengthened research and warning of plastic pollution, coordinated pollution disposal, and comprehensive remediation of plastic waste pollution in rural areas, so as to jointly prevent and treat plastic pollution upstream and downstream, on left and right banks, and on the water and the shores.

Recommendation 2

Strengthening interdepartmental collaboration for the strict control of plastic pollution throughout the whole process

The control of plastic pollution in the basin will be included as an important item on the agenda of the interministerial joint meeting concerning the full implementation of the RCS. Together with the relevant ministries and commissions, efforts will be made to promote the control of plastic pollution, make exchanges of experience in plastic pollution control, support the response to heavy cross-regional and cross-departmental plastic pollution, deepen the interministerial cooperation in plastic pollution control, and boost the organic combination of the RCS with the responsibility system of the plastic pollution control department to a higher level.

Led by a river chief, with the support of members including the NDRC, Ministry of Water Resources, and Ministry of Ecology and Environment, a plastic pollution control linkage mechanism will be established based on the ORCS as a platform to clarify their respective main management responsibilities, and will constitute joint efforts to control plastic pollution from the source to the sea. In terms of source control, the Ministry of Industry and Information Technology will conduct a thorough investigation of enterprises' production of obsolete plastics, to encourage the transformation and upgrading of enterprises and the conservation and intensive utilisation of resources; the Ministry of Agricultural and Rural Affairs will be responsible for the management of agricultural film; and the Ministry of Ecology and Environment will take the lead in investigating the sources of plastic pollution into rivers. In terms of waste disposal, the Ministry of Housing and Urban-Rural Development and other departments will supervise the classification, recycling, and recovery of resources from and harmless disposal of household waste; and the Ministry of Agricultural and Rural Affairs and other departments will recycle and dispose of fertiliser packaging waste, and remove plastic mulch residues from farmland. Regarding the end disposal of plastic waste in water, the Ministry of Housing and Urban-Rural Development and other departments will strengthen the construction of collection, interception, and disposal capacity of plastic waste in the urban rainwater and sewage pipe network; the Ministry of Water Resources will step up efforts to supervise any garbage heaps within the scope of the river channel under management, and will organise the campaign for removal of plastic waste from rivers, lakes, harbours, and beaches, cleaning these together with the Ministry of Ecology and Environment; the Ministry of Agricultural and Rural Affairs and other departments will put fishery-related disposal facilities and aquaculture-related agricultural plastic facilities into use and management to a greater extent; and the Ministry of Culture and Tourism and other departments will strengthen the collection and centralised disposal of domestic waste in water tours, and eliminate any accumulation of plastic waste before it enters the sea.

Recommendation 3

Building an improved joint enforcement and regulation mechanism to strengthen joint inspection and regulation of plastic pollution

Under the special coordination mechanism for the control of plastic pollution in the Yangtze River basin, the members will, in conjunction with related departments, and in strict accordance with the Environmental Protection Law, the Prevention and Control of Water Pollution Law, and the Yangtze River Protection Law, place the recycling, utilisation and disposal of plastic waste under regulation, and conduct daily management and protection including joint inspection and removal of plastic waste in transboundary waters by means of remote satellite sensing, unmanned aerial vehicles, video surveillance, and station network monitoring for the timely discovery and solving of related problems. Concerted efforts will be made to improve the processing and utilisation of plastic waste; investigate and punish any illegal discharging, littering, dumping, landfill, storage, and stacking of waste plastics; strictly implement discharge standards; control the total amount of pollution; and make clue transfer and case investigation for plastic pollution and ecological damage.

Recommendation 4

Promoting monitoring, evaluation, and information sharing of plastic pollution in the basin

Under the special coordination mechanism for the control of plastic pollution in the Yangtze River basin, the members will, in conjunction with related departments, conduct unified monitoring and evaluation indicators, standards, and technical methods for plastics and microplastics in the whole basin, and build a sound long-term monitoring system and regular working mechanism for plastic waste in waters. Regular surveys will be carried out on the status of plastic and microplastic pollution in such key areas as major agricultural production areas, urban industrial areas, important transboundary sections of rivers and lakes, and entrances and estuaries along the Yangtze River. A database will be established for plastic pollution in the Yangtze River basin, promoting the evaluation of plastic pollution in important sections of the Yangtze River basin, and the evaluation results used as an important reference for local implementation of RCS assessment, central environmental supervision, allocation of funds for ecological compensation, and decomposition of indicators of total pollutant discharge. A sound information-sharing mechanism will be established for plastic pollution in the whole basin, to strengthen the interconnection of plastic pollution control information between basins and regions, between regions, and between industries and departments, and share in a timely manner the state of plastic pollution within the scope of jurisdiction, pollution source information, monitoring data, report on river inspection and management, lists of problems found during the inspection , and its rectification.

Recommendation 5

Building a multi-stakeholder collaboration mechanism

To deepen multi-stakeholder collaboration on the control of plastic pollution in the Yangtze River basin, the linkage of upper and lower reaches, and joint consultation and management of the whole basin, will be promoted. Ways will be explored to construct a multi-stakeholder collaboration mechanism for the control of plastic pollution in the Yangtze River basin (details are given in the Appendix). The RCS will be used as leverage to build a consultation and coordination platform among stakeholders including the Government, enterprises, colleges and universities, research institutions, social organisations, and the public, for stepping up information sharing and disclosure, enabling the full performance of enterprises' main responsibilities, strengthening government supervision and management, providing policy guidance, building social consensus, guiding multiple subjects to jointly respond to plastic pollution, and intensifying the joint prevention and control of plastic pollution in the upper and lower reaches, the left and right banks, and the water and shores of the Yangtze River basin, thus forming a new pattern of plastic pollution prevention and control from source to sea, and continuously improving the environment in the Yangtze River basin.

6. Conclusions

While the RCS is becoming increasingly well known, very few studies have so far been able to show its potential with respect to tackling the plastic pollution problem. This paper has filled this gap by clearly demonstrating the advantages and applicability of the RCS approach in response to the growing plastic pollution issue in the Yangtze River basin.

Against this background, for the purpose of the paper, a MFA was conducted in Anhui Province, located in the lower reaches of the Yangtze River basin. The MFA allowed us to gain an insight into the main generation, disposal, distribution, and management of plastics in sections of the Yangtze River, and systematic analysis was made of China's current plastic pollution control-related management systems, policy measures, and control actions, following which the existing problems and shortcomings were analysed. Meanwhile, a thorough review of the existing policy and regulatory instruments in place was also presented. Having identified key institutional gaps, an analysis was made of the strengths and potential of the RCS in further controlling plastic pollution through the S2S process, and suggestions were proposed on strengthening the control of plastic pollution in the Yangtze River basin under the RCS.

Plastic debris are widely distributed in waters across the world, and have a great impact on ecosystems and organisms. The ecology and environment of the Yangtze River basin is directly related to the development of the YREB and people's health. However, due to the lack of long-term systematic monitoring, there is insufficient information on plastics and microplastics pollution in the Yangtze River basin. Anhui Province, a typical region in the lower reaches of the Yangtze River, was selected for MFA. By means of secondary collection, solid waste in the province was collected on a daily basis in urban areas, with self-organised collection in rural areas. A total of 70 percent of the waste plastics was effectively managed: 21 percent was recycled, 29.4 percent was land-filled, and 19.6 percent was incinerated. A total of 15 percent was left on land, and 2 percent, estimated equivalent to 175 tonnes/d, finally reached the sea.

Boats on the Yangtze River, Shishou, Jingzhou, China
Source: Freysteinn G. Jonsson.

An analysis was made of the weaknesses of China's current plastic pollution-related management policies and systems and collaborative management from source to sea, including :

- lack of laws at the national level for plastic management
- insufficient regulation of the prevention and control of pollution from land-based plastics into rivers, and the end control of plastic pollution in water
- indefinite division of functions and poor coordination among departments of plastic waste management, making it difficult to realise closed-loop management of plastic pollution
- the current prevention and control of plastic pollution mainly being subject to management within the jurisdiction, which is fragmented
- inadequate trans-provincial monitoring of plastic pollution, and a shortage of unified standards and technologies, a monitoring data-sharing system, and binding monitoring data
- low levels of engagement and collaboration of enterprises, social organisations, colleges and universities, research institutions, the public, and other stakeholders in the control of plastic pollution.

An analysis was made of the strengths and potential of the RCS in controlling plastic pollution in the basin:

- China has fully established a river and lake chief system and working mechanism, which provides an important organisational and institutional guarantee for the management and protection of rivers and lakes, such as the control of plastic pollution in the basin
- among the tasks under the RCS, arrangements were made for the prevention and control of water pollution, treatment of water environment, shoreline management and protection, and related enforcement and regulation, constituting great efforts to effectively implement plastic pollution control measures
- the RCS may coordinate the multiple plastic-related departments to strengthen horizontal cooperation between departments, and promote the creation of a collective force for water and pollution control
- under the RCS, a series of transboundary coordination mechanisms may facilitate the coordinated fulfilment of upstream and downstream, left and right banks, waterfront management, and protection goals and tasks, break the fragmented water management system, and strengthen cooperation and coordination in terms of the control of plastic pollution in the whole S2S system
- as a platform, the RCS may effectively boost the joint participation of enterprises, social organisations, and the public in the control of plastic pollution.

Finally, suggestions were proposed on strengthening the control of plastic pollution in the Yangtze River basin under the RCS:

- strengthening interdepartmental collaboration for strict control of plastic pollution throughout the whole process
- establishing a special coordination mechanism for the control of plastic pollution
- establishing a monitoring, evaluation, and information-sharing mechanism for plastic pollution in the basin
- building an improved enforcement and regulation mechanism to strengthen joint inspection and regulation of plastic pollution
- intensifying social and popular consensus in response to the challenge of plastic management for encouraging the participation of stakeholders.

Appendix

Proposal for an MSP for the control and monitoring of plastic pollution in the Yangtze River Basin (first draft)

Chapter I. General

Article 1.

For thoroughly implementing Xi Jinping's *Thought on Ecological Civilisation* and fulfilling the Yangtze River Protection Law of the People's Republic of China, the parties involved shall persist in "promoting well-coordinated environmental conservation and avoiding excessive development" and "prioritising ecological conservation and boosting green development"; deepen the multi-stakeholder cooperation for plastic pollution control in the Yangtze River basin; create the positive scenario of mutual coordination, joint consultation, and collaborative management across the basin; and establish multi-stakeholder partnerships for plastic pollution control in the Yangtze River basin (hereinafter referred to as the MSP).

Article 2.

The MSP aims to unite the all stakeholders involved in the prevention and control of plastic pollution in the Yangtze River basin, to cope with and solve plastic pollution challenges cooperatively; enhance joint against plastic pollution both upstream and downstream on both right and left banks and in both onshore and offshore areas of the Yangtze River basin; cohesively form a new source-to-sea pattern for plastic pollution prevention and control; continuously improve the aquatic ecology environment for the Yangtze River basin; and make efforts to establish a healthy river bringing benefits to the people.

Article 3.

It is proposed to adhere to the principles of making comprehensive plans, coordinating with a division of responsibilities, friendly consultation, diverse involvement and social participation, enhancing communication and coordination, promoting mutual support, and making full use of the MSP platform, to jointly advance the orderly implementation of plastic pollution control for the basin.

Chapter II. Work mechanism

Article 4.

It is proposed to carry out research for and establish a special coordination mechanism for the plastic pollution control in the Yangtze River basin. The coordination mechanism for plastic pollution control in the Yangtze River basin should be established by the basin agency assigned by the Ministry of Ecology and Environment of the People's Republic of China, in cooperation with the relevant departments of the provinces in the basin. The involved departments in the provinces shall establish the special coordination mechanism for interregional transboundary plastic pollution control as demanded, in order to collaboratively solve the salient transregional cross-department problems in plastic pollution.

Article 5.

It is proposed to carry out research for and establish a platform for communication and consultation among the governmental departments, enterprises, industrial organisations, and the public that is related to plastic pollution in the Yangtze River basin, to improve information sharing and disclosure, promote diverse involvement, make full use of the primary responsibility of enterprises, strengthen the supervision and management from the Government, enhance policy guidance, and consolidate social consensus, in order to advance the formation of the diverse co-control system in which the Government, enterprises, industrial organisations, and the public jointly participate.

Chapter III. Tasks

Article 6.

The MSP focuses on the main tasks of the plastic pollution control of the Yangtze River basin, mainly including:

(1) Joint consultation
The agencies dispatched by the Ministry of Ecology and Environment to the basin should collaborate with the related departments of each province to hold joint work meetings regularly or irregularly. In these meetings, they can study and jointly advance the related tasks for the MSP, exchange successful experience in plastic pollution control, coordinate to solve key and difficult problems, and summarise and promote the reproducible and generalisable experience and practices for coordinated plastic pollution control. Representatives of the pollution-related enterprises, industrial organisations, the public, or other involved parties can also be invited to participate in these meetings for consultation, according to arrangement.

(2) Joint patrol management and protection
It is proposed to establish a normalised joint patrol system for plastic pollution prevention and control; collaboratively carry out the environmental supervision and management of such stages as the recycling, utilisation, and treatment of plastic waste; enhance the cleaning and regulation of plastic waste along shorelines; make full use of measures such as satellite remote sensing, unmanned aerial vehicles, video monitoring, and network monitoring; and implement daily management and protection, including joint patrols and cleaning of plastic waste at transboundary waters, in order to find and solve the related problems in time.

(3) Joint enforcement and inspection
It is proposed to jointly carry out the examination and elimination of plastic pollution sources discharging into the river; remediation against agricultural plastic waste pollution; investigation and punishment according to the law of behaviours including the illegal discharge of plastic waste, random waste dumping, landfilling, storing, and stacking; the strict implementation of emissions standards; control of the total discharge amounts; evidence sharing and case accreditation and investigation of those guilty of environmental pollution and ecological vandalism; and rigorous action against illegal activities involving plastic pollution.

(4) Joint monitoring and control
In line with the principles of integrated planning, the division of tasks, and information sharing, it is proposed to establish a monitoring and control system against plastic pollution in the Yangtze River basin; unify the indexes, methods, and technical standards of plastic pollution at the trans-provincial level; and carry out joint monitoring and assessment of the major trans-province sections of the river.

(5) Information sharing and disclosure
It is proposed to enhance the sharing of trans-province and cross-department information on plastic pollution, including information about the hidden environmental risk hazard points within the basin or region, industrial pollution, household garbage, agricultural pollution sources, and water quality monitoring, and share relevant data with interested parties such as enterprises and the public, in order to realise the interconnectivity, co-building, and sharing of information about plastic pollution.

(6) Enhancing public oversight
It is proposed to encourage the pollution-related enterprises, industrial organisations, the public, and other interested parties to participate in the supervision over and protection against plastic pollution in the basin; establish and regulate the work process of the acceptance, treatment, verification, and feedback of evidence for problems involving plastic pollution; and encourage the related groups to investigate, deter, and report problems including the illegal blowdown and stacking of plastic pollution, to create the powerful synergy of the entire people's participation in water control and regulation for the basin.

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