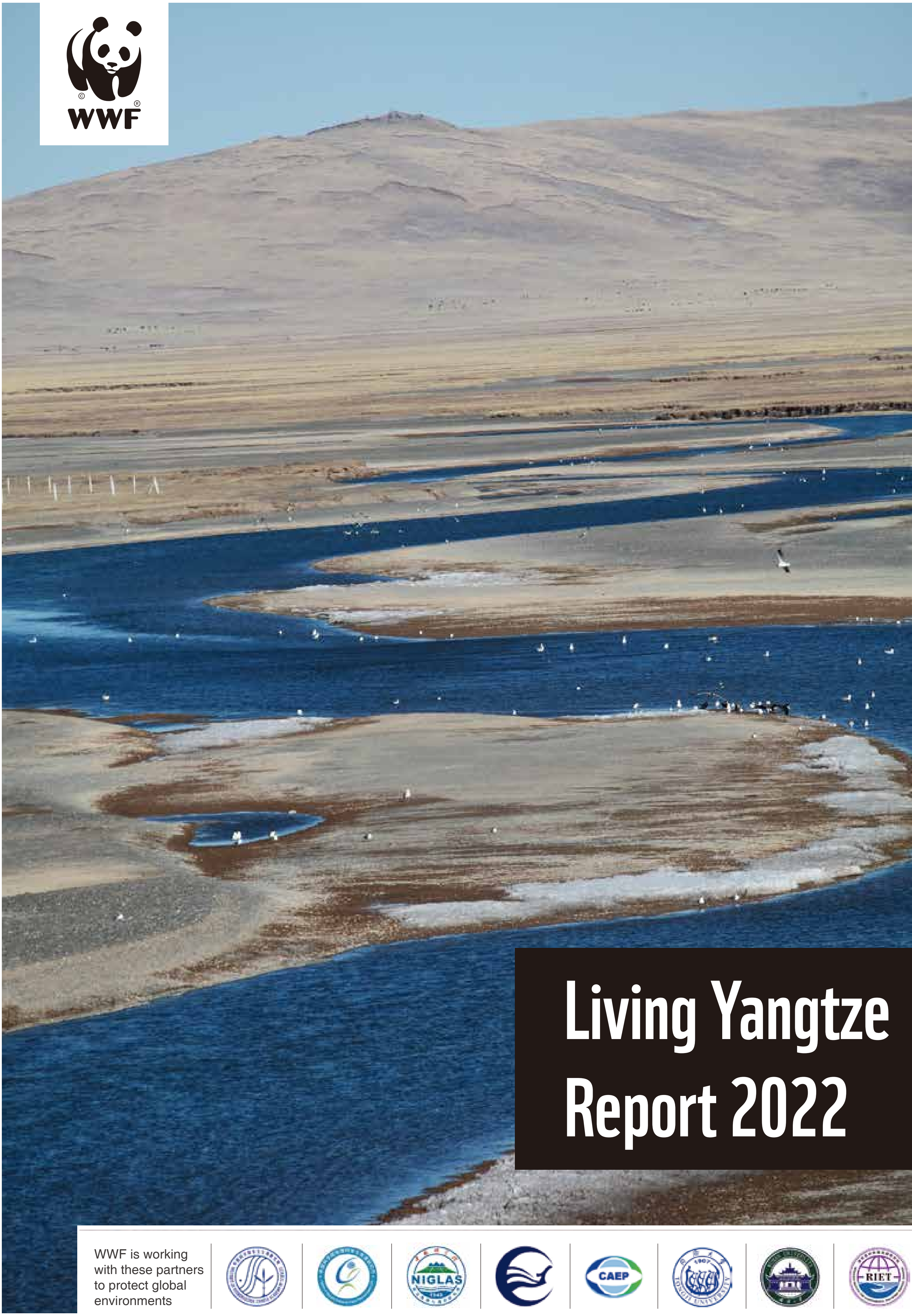


Living Yangtze Report 2022

WWF is working with these partners to protect global environments

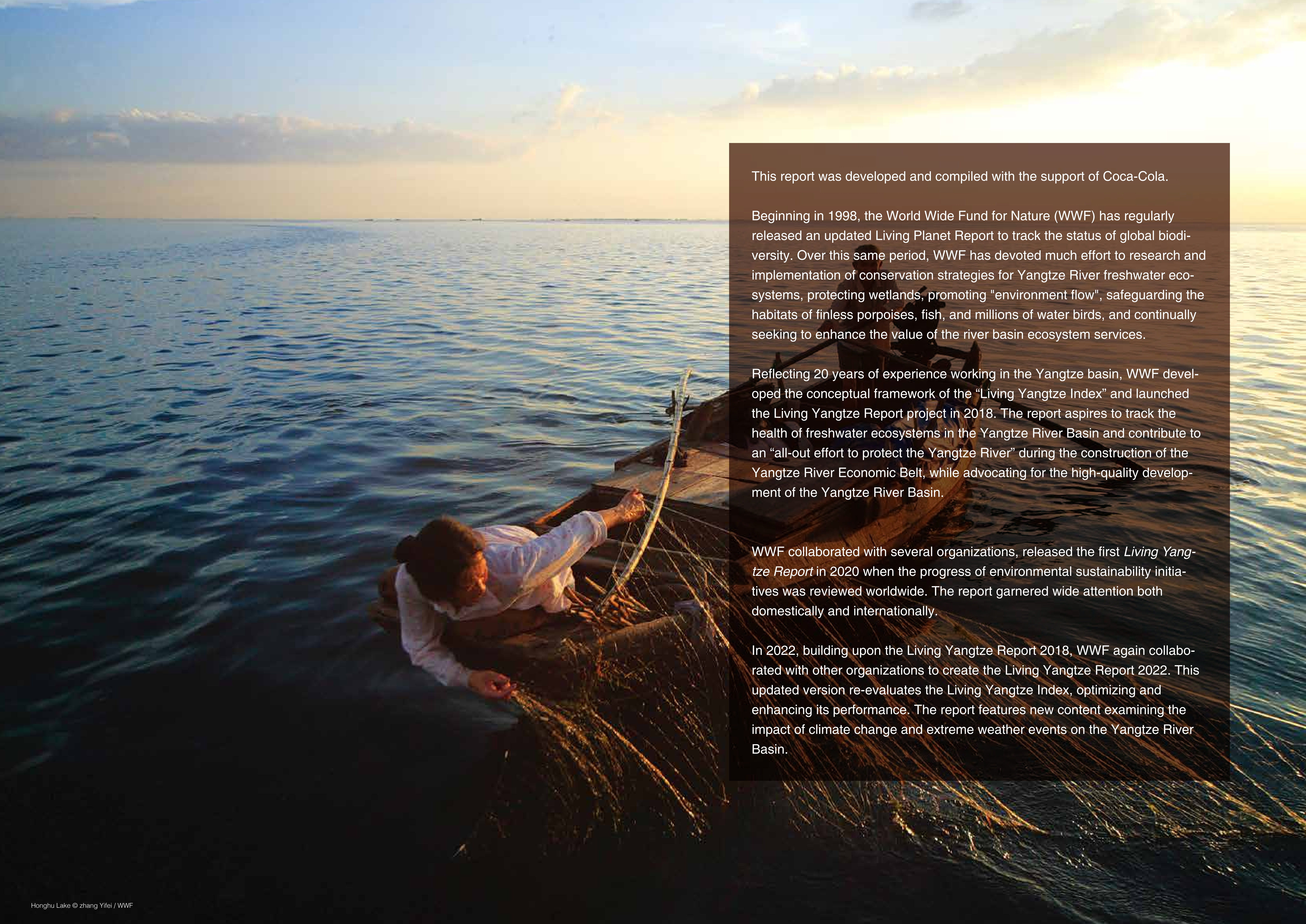
This report was developed and compiled with the support of Coca-Cola.

Beginning in 1998, the World Wide Fund for Nature (WWF) has regularly released an updated Living Planet Report to track the status of global biodiversity. Over this same period, WWF has devoted much effort to research and implementation of conservation strategies for Yangtze River freshwater ecosystems, protecting wetlands, promoting "environment flow", safeguarding the habitats of finless porpoises, fish, and millions of water birds, and continually seeking to enhance the value of the river basin ecosystem services.

Reflecting 20 years of experience working in the Yangtze basin, WWF developed the conceptual framework of the “Living Yangtze Index” and launched the Living Yangtze Report project in 2018. The report aspires to track the health of freshwater ecosystems in the Yangtze River Basin and contribute to an “all-out effort to protect the Yangtze River” during the construction of the Yangtze River Economic Belt, while advocating for the high-quality development of the Yangtze River Basin.

WWF collaborated with several organizations, released the first *Living Yangtze Report* in 2020 when the progress of environmental sustainability initiatives was reviewed worldwide. The report garnered wide attention both domestically and internationally.

In 2022, building upon the Living Yangtze Report 2018, WWF again collaborated with other organizations to create the Living Yangtze Report 2022. This updated version re-evaluates the Living Yangtze Index, optimizing and enhancing its performance. The report features new content examining the impact of climate change and extreme weather events on the Yangtze River Basin.



Honghu Lake © zhang Yifei / WWF

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Acknowledgement

The living Yangtze River presents not only achievements of environmental restoration and governance in the region, but challenges that resonate with other important rivers around the globe. The Living Yangtze Report 2022 serves not just as a call, but as a concrete action for collaborative endeavors for the prosperity for all-living-beings on the planet from now to the future. The making of the English version of the report was made possible through the insights and dedication from professionals of diverse institutions across the world.

We would like to express our sincere gratitude to the expert Richard Lee for his valuable insights provided for this report, and extend our heartfelt appreciation to the following experts for their contributions to the specialized section of this report: Wenxi Feng, Chuanbin Zhou, Wenfang Huang, Jiarong Lai, Qian Wang, Mengqi Ma, and Guoguang Li.

A special thanks goes to Executive Editor Yanfei Liu for his work on this report.

Among this collect of colleagues on this project, a group of expertise from Queen's University (Canada) and the Sino-Canada Center for the Environmental and Sustainable Development provided valuable input to elevate the English version of the report into an articulate and coherent composition. Dr. Stephen Lougheed combed through the report and provided detailed comments to refine the expression of the report for a broader readership. Drs. Brian Cumming, Yuxiang Wang, and Bingru Yue contributed to the interpretation of many key concepts comprehensively Dr. Bojian Chen and Dr. Jeff Ridal at the St. Lawrence River Institute also brought in many valuable insights on the roles of river system play in cultivating human civilization. With deep gratitude, the Living Yangtze Report 2022 acknowledges the inputs received from all contributing parties.

CONTENTS

ChenYiyu

Member,
Chinese Academy of Sciences

FORWARD

I am excited to hear that the Living Yangtze Report 2022 will soon be released.

In 2020, I had the pleasure of reading the first edition of the Living Yangtze Report and found it to be excellent. The Yangtze River Basin is listed as one of 35 priority ecological areas in the world according to WWF, owing to its remarkable biodiversity. What sets the Yangtze River Basin apart from other major river systems worldwide are its distinct features. It is one of the cradles of the Chinese civilization as it has witnessed a long history of the interactions between human activities and natural ecosystems. The river has provided abundant resources, information, and capital to drive high quality economic and social development in China. The Yangtze River Economic Belt has been one of the most prosperous areas nationally, contributing around 45% to China's GDP. However, the Yangtze River Basin is affected seriously by human activities. During the past six years, President Xi Jinping has delivered three important speeches to protect the river while ensuring the continued economic development of the Yangtze River Economic Belt. His calls to "promote well-coordinated environmental conservation and avoid excessive development" have gained consensus and become a guiding principle for Chinese society.

The Living Yangtze Report 2020 begins with a description of the Yangtze River's state as "seriously sick," and proposes a search for a cure. The report adopts the holistic perspective drawing from Traditional Chinese Medicine (TCM) to trace the source of the river's malaise, diagnose the underlying causes, identify the root issues, derive objective mitigation measures, and implement systematic treatment. By incorporating the philosophy of TCM, the report studies of the health status of the Yangtze River ecosystem, making it accessible to a broad audience, including the general public, businesses, and government agencies to understand the threats to the Yangtze River ecosystem. The report provides scientific guidance to national authorities, river basin management institutions, and local governments in their decision-making. Its influence has been significant, and it has garnered high praise from stakeholders.

Since the implementation of Yangtze River Protection six years ago, a series of policies and special actions to safeguard the river's health has been launched, such as the implementation of the Yangtze River Protection Law, the 10-year fishing ban, the battle against water pollution, environmental protection inspectors, the river and lake chief system. The ecological protection of the Yangtze River has been effective, as the water quality especially has improved significantly, and the ecosystem degradation has been effectively mitigated.

The Yangtze River has experienced extreme weather and hydrological events over the past two years, including a severe flood in 2020, and the record-breaking heatwave and drought of 2022. The Living Yangtze Report 2022 explores and recognizes the impacts of climate change and the effects of the implementation of the major policies on the Yangze River Basin. The report also continues the study of the long-term environmental indicators, including hydrology, water quality, and aquatic biota. In addition, the Report offers suggestions for the protection of the Yangtze River, including policies, technological methods, and public participation.

Over the past two decades, WWF's biennial Living Planet Report has made a significant impact worldwide. The report plays a unique role in raising public awareness of the health of the planet, inspiring industries to take action, and helping to build consensus among countries to reverse the decline of biodiversity. Restoring the Yangtze River ecosystem is a long-term and complicated task that has only just begun. For instance, the Ten-Year Fishing Ban has been in effect for two years, and further observation and research are necessary. I hope that WWF and research institutions will persist in working on the Living Yangtze project to make a special contribution to the restoration while enabling high-quality development of the Yangtze River Basin.

Kirsten Schuijt

Director General,
WWF International

FORWARD

A healthy Yangtze River is critical to China's future. The river basin is home to hundreds of millions of people and it is essential for the security of food and water, human health, rural and urban development, and economic growth. It is also home to extraordinary biodiversity – from the world's only freshwater porpoise to giant pandas, snow leopards, over 400 species of freshwater fish and millions of migratory birds.

WWF is proud to have partnered with many leading Chinese academic institutions on the development of this Living Yangtze Report. The first report in 2020 provided an unprecedented overview of the status of the basin, which supported more effective conservation and management of the basin.

The Living Yangtze Report 2022 gives us cause for optimism as it shows clear improvements over the past two years in the health of the Yangtze – thanks to concerted efforts by governments, corporations and the public.

This welcome news demonstrates that collective conservation action – including major new laws on river and wetland protection – can help to address the enormous challenges facing the world's third longest river. But there is, of course, much more work to do.

This year's report optimises the Living Yangtze Index to deliver an even more authoritative analysis of the basin. This will help decision-makers decide the best steps to take to boost biodiversity conservation and ecosystem restoration, and ensure the sustainability of the river's priceless natural resources.

The report highlights the increasing threat posed by climate change to the vitality and resilience of the Yangtze. The drought and record low river levels in the summer of 2022 underlined the scale of this threat and the need for even greater conservation action and collaboration.

Resilient rivers are critical to tackling the climate and nature crises around the globe, and they are key for sustainable development. Across the globe, awareness is growing of the importance of healthy rivers, and so too the calls to conserve and sustainably manage them.

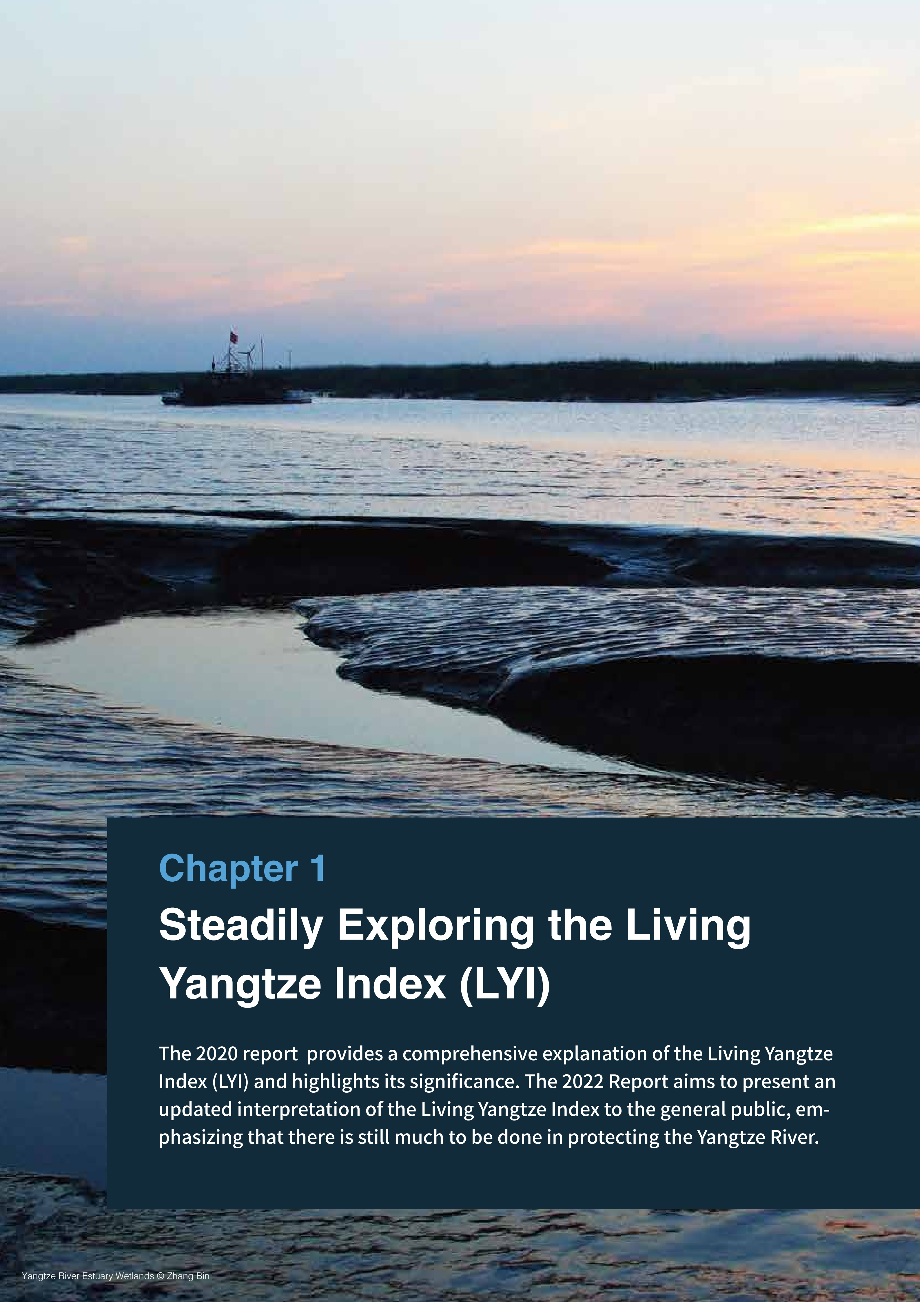
In November 2022, all countries agreed for the first time at the UNFCCC COP27 that healthy river basins are critical to climate action, particularly adaptation. In December, under the Presidency of China, the world adopted an ambitious Global Biodiversity Framework at the Convention on Biological Diversity COP15. The agreement includes specific text related to the protection and restoration of inland waters, focusing attention on the need for urgent action to tackle the damage we have done to our rivers. It is critical that we take action to reverse the average 83 per cent collapse in freshwater species populations since 1970.

And while this report highlights positive changes in most stretches of the river, it also recommends additional measures to drive further progress – from strengthening climate change monitoring, to improving flood and drought mitigation, and tackling plastic pollution.

Restoring the Yangtze is a long-term and difficult task. But it is possible.

Thanks to the Living Yangtze Report 2022, we now have a much more accurate picture of the health of Asia's longest river and how best to enhance it, for the benefit of all the millions of people living there and the rich biodiversity it supports. The report and the Living Yangtze Index – the only basin-level index in the world – will hopefully be replicated across the world, especially now that the second report has showcased the impact and importance of regularly updating river basin health data.

WWF has been working along the Yangtze for decades and it is hugely encouraging to see the evidence of real progress. I am confident that this report will – like its predecessor – contribute significantly to collective efforts to conserve, restore and sustainably manage the Yangtze River for the benefit of people and nature.



Yangtze River Estuary Wetlands © Zhang Bin

Chapter 1

Steadily Exploring the Living Yangtze Index (LYI)

The 2020 report provides a comprehensive explanation of the Living Yangtze Index (LYI) and highlights its significance. The 2022 Report aims to present an updated interpretation of the Living Yangtze Index to the general public, emphasizing that there is still much to be done in protecting the Yangtze River.

1.1 Reinterpretation of the Living Yangtze Index

The Living Yangtze Index focuses on three critical environmental components that contribute to the health of Yangtze River Basin ecosystems: hydrological processes, water quality, and aquatic biota. These three elements are considered fundamental to the ecosystem's well-being.

Over the past two decades, the World Wild Fund for Nature (WWF) has been devoted to research and practice the protection of freshwater ecosystems in the Yangtze River. Collaborating with Chinese government agenciess and other stakeholders, WWF has conducted a series of research projects and various campaigns. These efforts include the conservation of Ramsar Wetland sites, such as Dongting Lake, Poyang Lake, Hong Lake, and the Chongming Dongtan Reserve. WWF has demonstrated and promoted the technique of adopting fries. The project to restore the environment flow in the Yangtze River was launched. To inspire and involve younger generations, WWF initiated the Wetland Ambassador Action. WWF also established several important platforms, including the Yangtze Wetland Network, the Yangtze Forum, and the Taihu Water Stewardship Forum. These serve as accessible means for stakeholder paticipation, facilitating collaboration working towards the ultimate goal of protection of the Yangtze finless porpoise.

In 2018, WWF initiated the "Living Yangtze Report" project in partnership with the Changjiang (the Chinese spelling for Yangtze) River Scientific Research Institute (CRSRI), the Research Institute for Environmental Innovation (Suzhou) Tsinghua (RIET), the Chinese Academy of Environmental Planning (CAEP), the Key Laboratory of Yangtze River Water Environment, Ministry of Education (Tongji University) (KLYRWE), the Institute of Geographic Sciences and Natural Resources Research, the Chinese Academy of Sciences (IGSNRR), the Institute of Hydrobiology, Chinese Academy of Sciences (IHB), the Nanjing Institute of Geography & Limnology, Chinese Academy of Sciences (NIGLAS), and the School of Water Resources and Hydropower Engineering (SWRHE), Wuhan University. The project aims to provide a comprehensive and objective diagnostic report on the health status of the Yangtze River. The report offers technical support for environmental protection in the Yangtze River Basin and the implementation of green development of the Yangtze River Economic Belt. Further, the report provides policy recommendations on protecting and managing Yangtze River ecosystems to encourage various stakeholders to actively participate in protecting the Yangtze River.

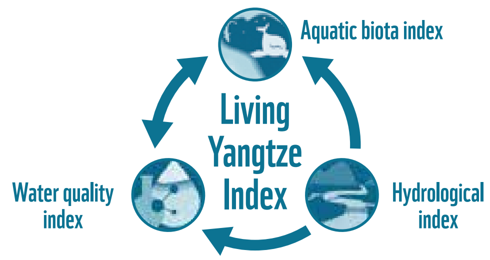


Fig. 1-1 Three dimensions of the Living Yangtze Index

The first Living Yangtze Report 2020 (hereinafter -the 2020 Report) was released at the end of 2020 and achieved significant social impact.

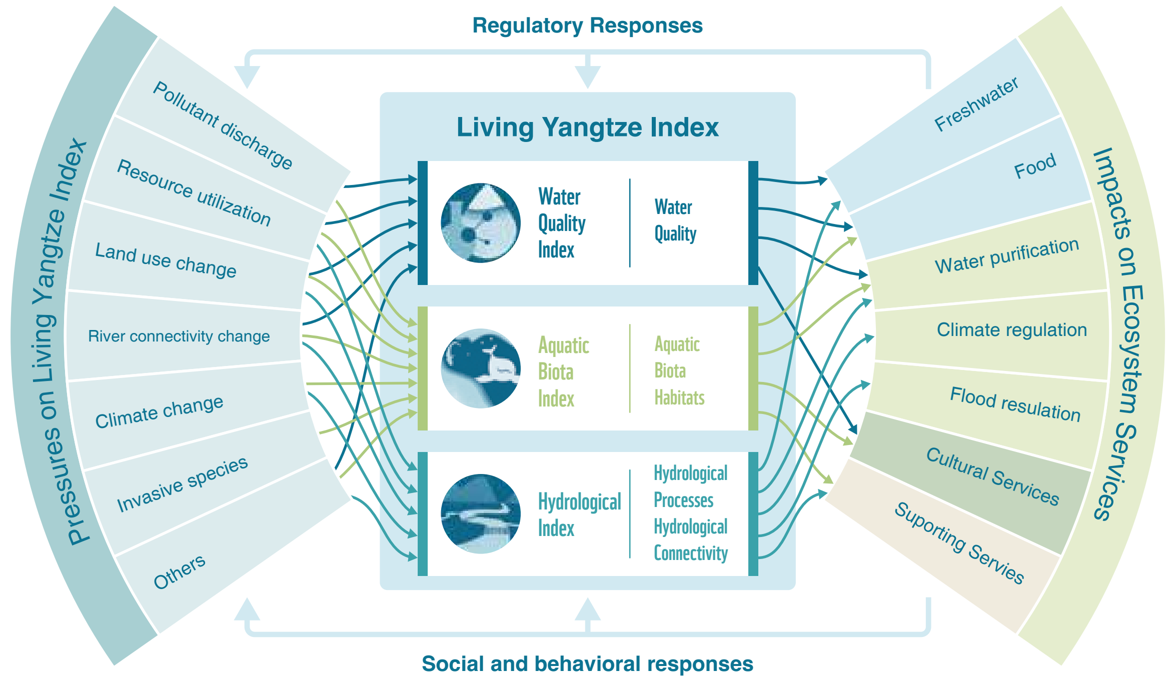


Fig.1-2 Conceptual framework of the Living Yangtze Report

There are three critical environmental components that contribute to the health of the Yangtze River Basin ecosystem: hydrological processes, water quality, and aquatic biota.

At the core of the Living Yangtze Report 2022 (hereinafter – the 2022 Report) is the Living Yangtze Index, which comprises three critical compsite indicators: hydrology (hydrological processes and connectivity), water quality, and aquatic biota (including fish species present, fish larvae, and numbers of the Yangtze finless porpoise.)

In contrast to the 2020 Report, the 2022 Report has updated the Living Yangtze Index's indicator system by incorporating evaluations of Dianchi Lake, Chishui River, and Hong Lake. However, the essential calculation methods, weights assigned to specific factors, and evaluation criteria of the indicators remain unchanged.

The ultimate reflection of the health of the Yangtze River is in its ability to provide multiple ecosystem services sustainably for both nature and humans. Therefore, it is not necessary to evaluate short-term changes in ecosystem service functions within the conceptual framework of the Living Yangtze Index.

The "2022 Report" enphasises the changes in the Living Yangtze Index. Also included was a preliminary assessment to examine the variations under the influence of policies and regulations introduced by the central government and related governmental departments in recent years concerning the conservation of the Yangtze River.

The 2022 Report presents an analysis of the primary changes in pressures and factors affecting Yangtze River freshwater ecosystems; this led us to introduce new content that is closely linked to the health status of Yangtze River ecosystems. These include incorporating consideration of environment flow regulation, water pollution prevention, the impacts of the ten-year fishing ban, climate change, and extreme weather. The 2022 Report offers corresponding strategies and suggestions to address current challenges faced by Yangtze ecosystems.

It is important to note that the data presented in the 2022 Report are extracted primarily from government bulletins, academic publications, and scientific research conducted by WWF's partners. The 2022 Report is compiled based on data from 2019 to 2020, with the exception of water quality data, which is up to 2021. The physical evaluation units used are as follows: the Source of the Yangtze River (above the Zhimenda station), the Upper Yangtze River (Jinsha River basin, Mingjiang-Tuojiang River, Jialing River, Wujiang River and Yibin-Yichang Section), the Middle Yangtze (Hanjiang River, Yichang-Hukou Section, excluding Dongting Lake and Poyang Lake), the Lower Yangtze River (Trunk stem of the Yangtze below Hukou), the Dongting Lake, Poyang Lake, and the lower Chaohu, and Taihu lakes (hereafter – the Four Lakes). Evaluation of aquatic biota index-related indicators pertains to the main channel of the Yangtze River and the Four Lakes.

We are confident that the 2022 Report will deepen your understanding of the Yangtze River and provide you with valuable insights on Living Yangtze Index. Our intention is that the report will inspire individuals who reside along the Yangtze River and who have concerns about the health of the river to actively participate in the conservation and development of the Yangtze River Economic Belt.

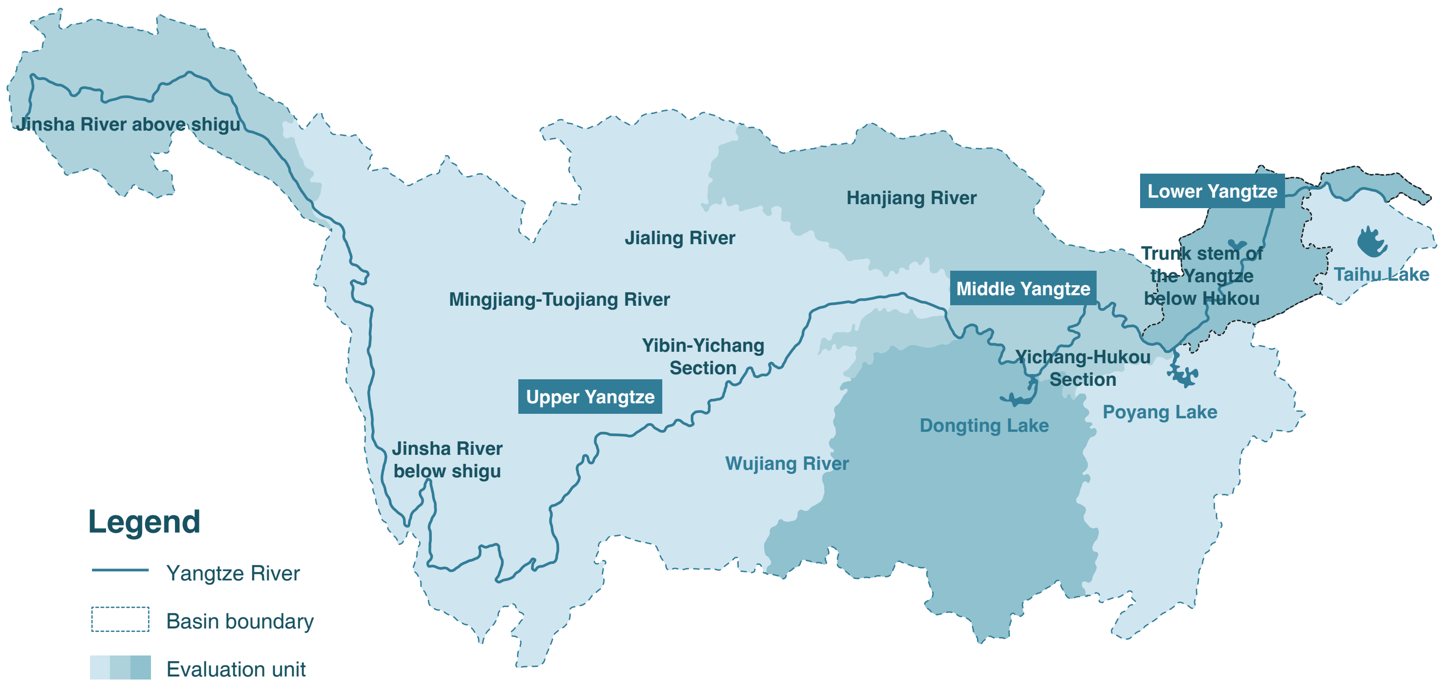


Fig.1-3 Evaluation scope of the Living Yangtze Index

1.2 The Conclusions of the Living Yangtze Index

In comparison to information contained in the 2020 Report, the Living Yangtze Index results of the 2022 Report have shown slight improvement, which can be attributed to protection efforts by relevant national bureaus, as well as provincial and municipal governments along the river.

The Living Yangtze Index presents an overview of the health status of Yangtze River ecosystems, including both its main channel and the Four Lakes region incorporating consideration of the three main indicators, including hydrology, water quality, and aquatic biota.

The comprehensive evaluation of the Living Yangtze (see Figure 1-4) reveals variation in the LYI across different sections of the Yangtze River and the Four Lakes region. The Living Index of the Yangtze River mainstem is 0.69, with a grade of B minus. this represents a slight improvement from the LYI score of 0.66 reported in 2020.

The Source of Yangtze River LYI has a value of 0.97, which is a decrease of 0.03 from 2020, receiving a grade of A.

The Upper Yangtze River LYI received a value of 0.67, which is an increase of 0.02 from 2020, with a grade of B minus.

The middle Yangtze River LIY has a value of 0.55, which is an increase of 0.04 from 2020, with a grade of C.

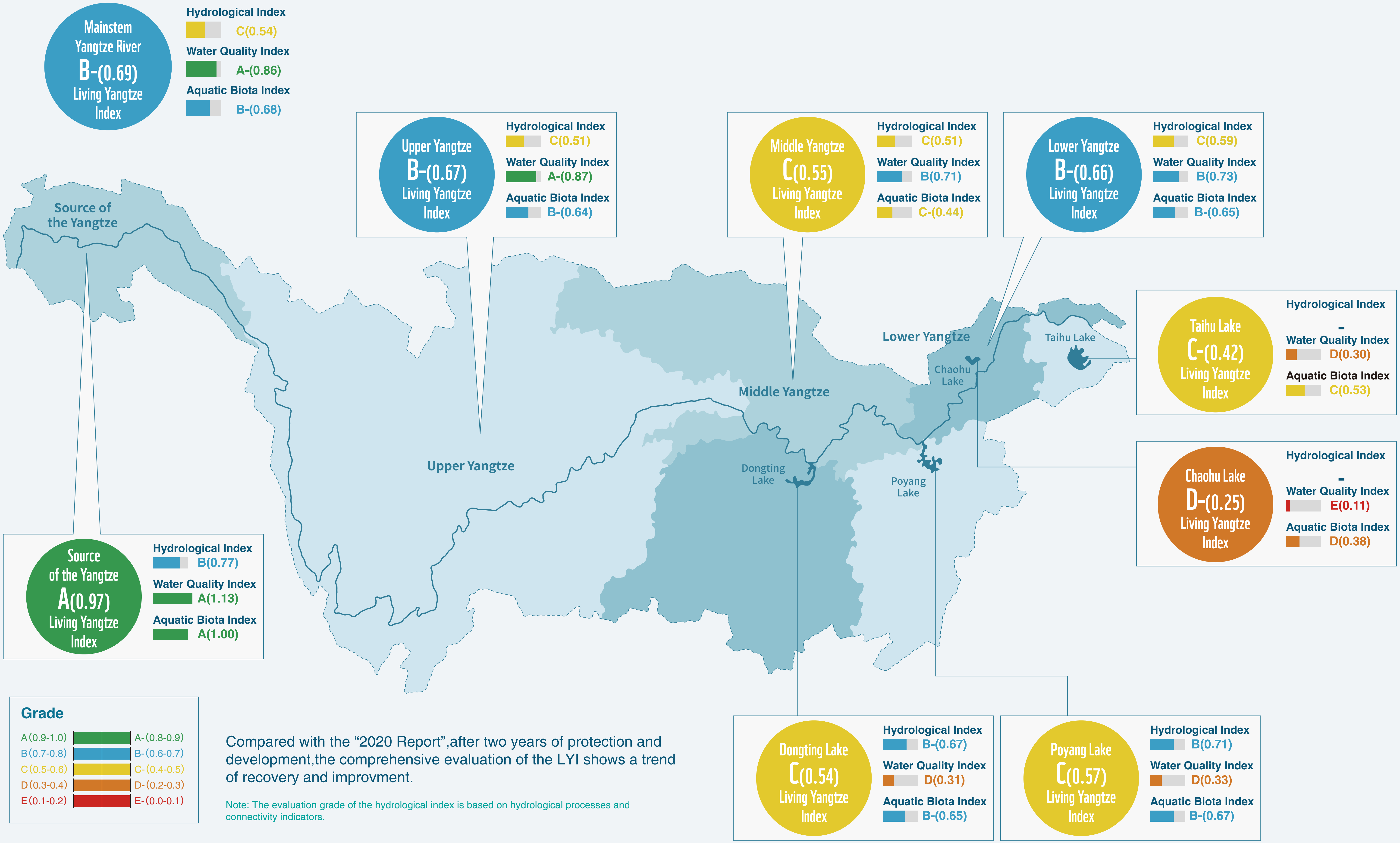
The Lower Yangtze River LIY has a value of 0.66, which is an increase of 0.05 from 2020 and with a grade of B minus.

The evaluation grade for Dongting Lake and Poyang Lake is C, Taihu Lake is C minus. The grade for Chaohu Lake is D minus. Unfortunately, Taihu Lake and Chaohu Lake continue to face significant threats, as reflected by Chaohu Lake's declining Living Index score of 0.25, compared to its core in 2020 (see Table 1-1 for details).

Table 1-1 Comprehensive LYI of the Yangtze River and the Four Lakes

	Hydrological Index		Water Quality Index	Aquatic Biota Index	2022 LYI Index	2020 LYI Index
	Hydrological processes	Connectivity	Water quality	Biota		
Source of the Yangtze	0.54	1.00	1.13	1.00	0.97	1.00
Upper Yangtze	0.46	0.55	0.87	0.64	0.67	0.65
Middle Yangtze	0.52	0.49	0.71	0.44	0.55	0.51
Lower Yangtze	0.54	0.63	0.73	0.65	0.66	0.61
Dongting Lake	0.60	0.73	0.31	0.65	0.54	0.54
Poyang Lake	0.68	0.74	0.33	0.67	0.57	0.57
Taihu Lake	-*	-*	0.30	0.53	0.42	0.35
Chaohu Lake	-*	-*	0.11	0.38	0.25	0.29

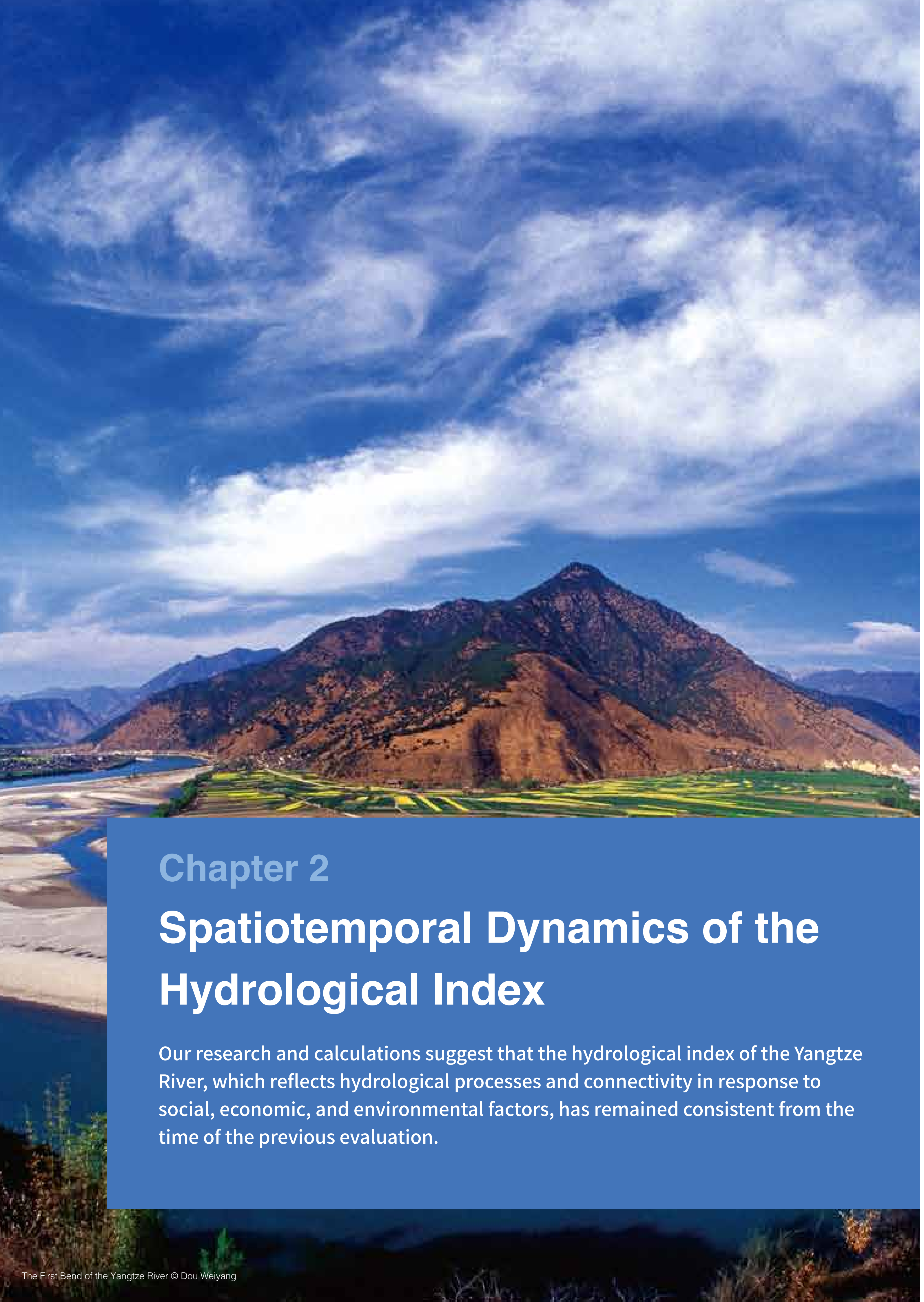
(Note: Taihu Lake and Chaohu Lake were not included in the evaluation of hydrological indices as they were not connected to the Yangtze River during the period of evaluation.)



Compared with the “2020 Report”,after two years of protection and development,the comprehensive evaluation of the LYI shows a trend of recovery and improvment.

Note: The evaluation grade of the hydrological index is based on hydrological processes and connectivity indicators.

Fig. 1-4 2022 Comprehensive LYI of the Yangtze River Mainstem and the "Four Lakes"



The First Bend of the Yangtze River © Dou Weiyang

Chapter 2

Spatiotemporal Dynamics of the Hydrological Index

Our research and calculations suggest that the hydrological index of the Yangtze River, which reflects hydrological processes and connectivity in response to social, economic, and environmental factors, has remained consistent from the time of the previous evaluation.

2.1 Hydrological Index of the Yangtze River Mainstem and the "Four Lakes"

The hydrological index varies across different sections of the Yangtze River, including the Source Section,Upper Section, Middle Section, Lower Section and Four Lakes Region.

Evaluation Indicators of Hydrological Index

The calculation method for the hydrological index in the 2022 Report remained consistent with the 2020 Report. It involves two types of indicators: a hydrological processes indicator and a connectivity indicator. For our purposes, the Yangtze River is divided into four sections: the Source Section, Upper Section, Middle Section, and Lower Section. Additionally, the hydrological index for Poyang Lake and Dongting Lake were calculated and the results were compared with those obtained in the 2020 Report.

The hydrological index of the Yangtze River in the 2022 report was estimated to be 0.54, resulting in a grade of C, similar to what was reported in the 2020 Report.

Yangtze River Mainstem Hydrological Index

The hydrological index for the Yangtze River main channel was estimated to be 0.59, receiving a grade of C. Among the different sections of the river, the evaluation grade for the Source of the Yangtze River is B, the Upper Yangtze River is C, the Middle Section is C, and the Lower Section is C. In addition, the new evaluation grade for Dongting Lake is B minus, and for Poyang Lake is B

The hydrological index of the Source of the Yangtze River is B.

The evaluation result of the hydrological index for the Source of the Yangtze River is 0.77, with a grade of B. In the previous evaluation, the result was 0.82, with a grade of A minus. In the 2022 Report, the hydrological process indicators received an evaluation result of 0.54, while the connectivity indicator received a value of 1.

The hydrological index of the upper Yangtze River is C

The hydrological index evaluation result for the upper Yangtze River is 0.51, with a grade of C. The previous evaluation result was 0.55, with a grade of C. The hydrological processes indicator is 0.46, and the connectivity indicator is 0.55.

The hydrological index for the Middle Yangtze River is C

The hydrological index evaluation result for the Middle Yangtze River is 0.51, with a grade of C. The previous evaluation result was 0.48, with a grade of C minus. The hydrological process indicator is 0.52, and the connectivity indicator is 0.49.

The hydrological index for the Lower Yangtze River is C

The hydrological index evaluation result for the lower Yangtze River is 0.59, receiving a grade of C. The previous evaluation result was 0.62, with a grade of B minus. The hydrological process indicator is 0.54, and the connectivity indicator is 0.63.

Hydrological Index of the "Four Lakes" in the Yangtze River Basin

The hydrological index evaluation result for Dongting Lake is B minus and for Poyang Lake is B, similar to the previous evaluation. As both Dongting Lake and Poyang Lake are connected to the Yangtze River, the connectivity indicator is affected by connectivity of the inflowing tributaries (see Table 2-1).

Table2-1 Evaluation Results of Hydrological Index for Yangtze River Mainstem and "Four Lakes"

	Hydrological Index		Hydrological Index	Hydrological Index Grade	2020 Hydrological Index	2020 Hydrological Index Grade
	Hydrological	Connectivity				
Source of the Yangtze	0.54	1	0.77	B	0.82	A-
Upper Yangtze	0.46	0.55	0.51	C	0.55	C
Middle Yangtze	0.52	0.49	0.51	C	0.48	C-
Lower Yangtze	0.54	0.63	0.59	C	0.62	B-
Dongting Lake	0.60	0.73	0.67	B-	0.66	B-
Poyang Lake	0.68	0.74	0.71	B	0.73	B
Taihu Lake	-*	-*				
Chaohu Lake	-*	-*				

(Note: Taihu Lake and Chaohu Lake were not included in the evaluation of hydrological indices as they were not connected to the Yangtze River during the period of evaluation.)

2.2 Spatiotemporal Differences in Hydrological Index between the Yangtze River Mainstem and the "Four Lakes"

The hydrological index is greatly influenced by the runoff regime, with a higher value associated with more stable runoff conditions.

The calculation results for the core hydrological process index at the control stations of the Yangtze River Mainstem and its tributaries from 2016 to 2020 are displayed in Figure 2-1.

As depicted in Figure 2-1, the Poyang Lake Basin has the highest core index value at 0.70, followed by the Source of the Yangtze River and Dongting Lake, both at 0.63. The Minjiang River, a tributary of the Upper Yangtze River, has the lowest core index value at 0.44. Additionally, Cuntan, a control station in the Upper Yangtze River main channel, has a core index value at 0.45, while Wujing and Hanjiang both received a core index value of 0.50.

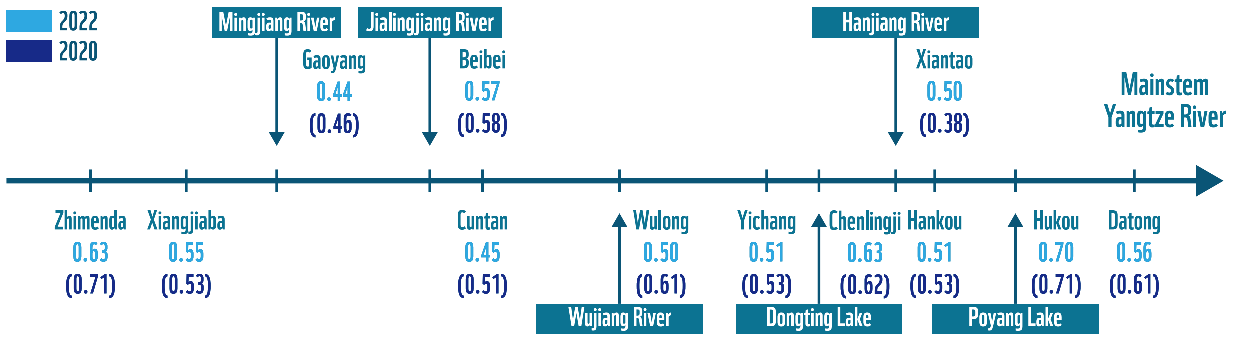


Fig. 2-1 Core Hydrological Process Index Results of the Yangtze River Mainstem and Tributaries (Results from "2020 Report" in the parentheses)

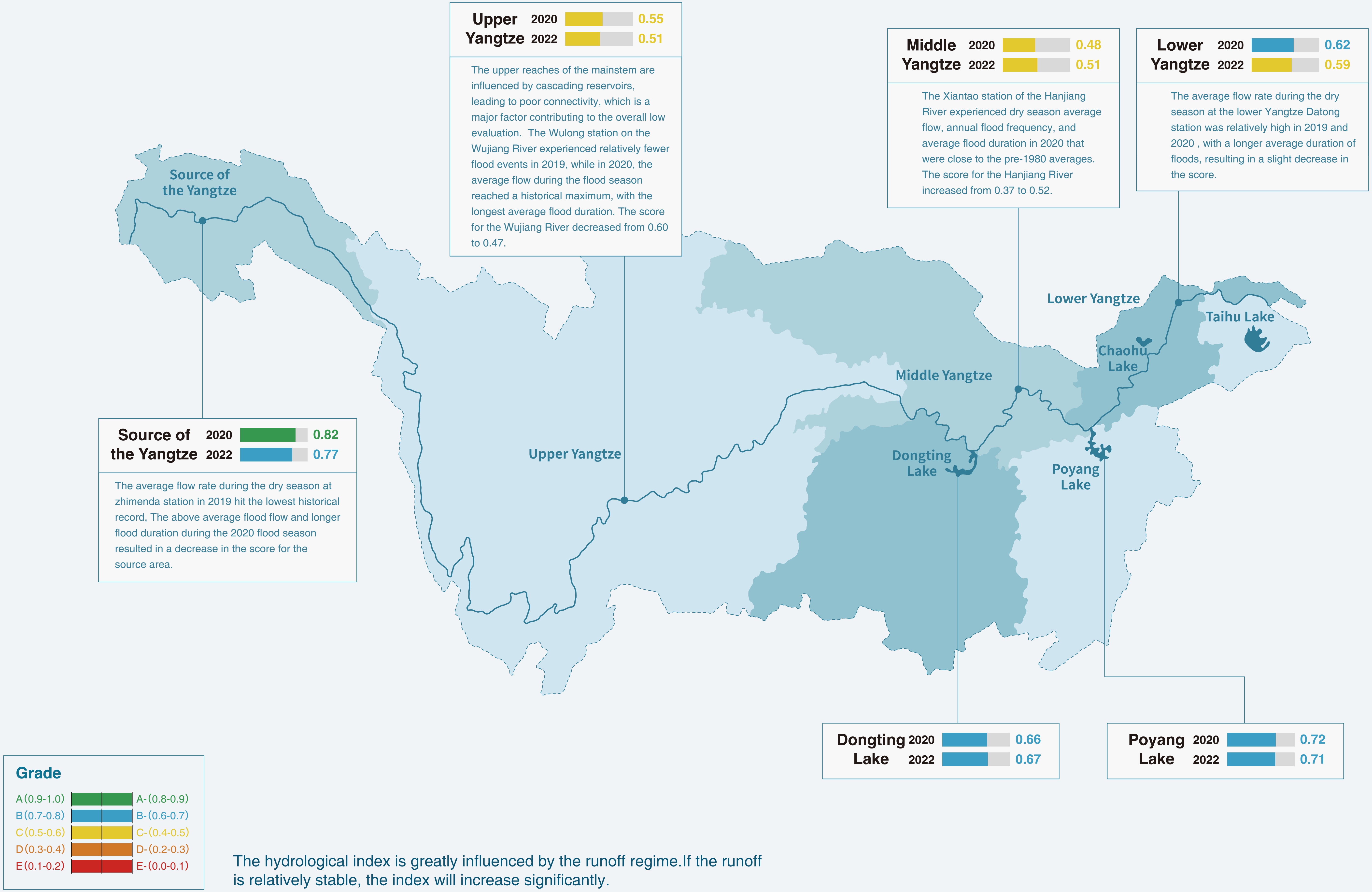
The high value of the core index for the Poyang Lake Basin can be attributed to the average flow during the flood season and the dry season in 2020 being close to the background value. Due to the 2020 flood that affected the entire basin, the scores of the other sites are lower.

The high core index of the Source of the Yangtze River is mainly due to its excellent connectivity, which is scored as 1.00. Similarly, the Dongting Lake Basin received a high core index score due to the average flood duration in 2019 and the average dry season flow rate in 2020 being close to the background values.

Comparison of the 2020 and 2022 reports reveals that both hydrological process and connectivity indicators are affected by the runoff regime. For instance, floods or droughts can result in significant deviations in hydrological processes and connectivity indices from background values, leading to a lower score. The 2020 flood in the Yangtze River Basin caused hydrological extremes in most of the tributaries, resulting in a decrease in the hydrological process indicator score. Moreover, the cascade reservoirs, a series of impounding reservoirs on the Yangtze River and its tributaries, disrupted the river hydrological process, causing regulated runoff to become irregular and resulting in a lower score for the river connectivity indicator.

Flying Pide Avocet over Dongting Lake © Zhang Yifei / WWF

The Three Gorges Dam © LiMing



The hydrological index is greatly influenced by the runoff regime.If the runoff is relatively stable, the index will increase significantly.

Fig. 2-2 Spatiotemporal Changes in the Hydrological Index of the Yangtze River and "Four Lakes" in 2020 and 2022

2.3 Environment flow Monitoring and Management: Hydrological Pressure and Policy Response

The objective of environment flow monitoring and management in the Yangtze River Basin is to ensure a sustainable flow regime reflecting good water quality, sufficient quantity, and appropriate spatiotemporal distribution for the entire Yangtze River Basin and its associated ecosystems.

The construction of large-scale water conservancy projects and land reclamation in the upper and Middle Reaches of the Yangtze River has disrupted the natural water flow of the basin, resulting in changes to hydrological processes and connectivity. Moreover, the uncontrolled and excessive construction of small hydropower stations in the basin has negatively impacted the hydrological conditions of the rivers during the dry season, disrupting the environment flow and causing severe damage to river connectivity, with far-reaching implications for the river ecosystems.

The objective of monitoring and managing environment flow in the Yangtze River Basin is to provide a sustainable flow regime that ensures adequate water quality, quantity and spatiotemporal distribution for the entire Yangtze River Basin and its ecosystems. To achieve this, it is essential to implement a series of engineering and non-engineering measures, such as the coordinated operation of cascade reservoirs, establishment of a sound flow management mechanisms, and continuous monitoring and management of flow. These measures will help maintain healthy basin-wide ecosystems and ensure the sustainable use of water resources.

In December 2018, the Chinese government launched a cleanup and rectification campaign aimed at small hydropower stations within the Yangtze River Economic Belt region. Taking Chishui River as an example, 197 small hydropower stations were removed by the end of June 2022, accounting for 54% of all the hydropower stations slated for decommissioning in the region.

In 2019, the Ministry of Water Resources and Ministry of Ecology and Environment issued a Notice on Strengthening the Supervision of environment flow of Small-scale Hydropower Stations in the Yangtze River Economic Belt. The Notice calls for strengthening the supervision and management of flow in small hydropower stations in the Yangtze River Economic Belt to ensure ecological integrity of riverine systems, and to establish a sound and long-term mechanism to ensure sustained flow, and flow protection of small hydropower stations before 2020.

In 2021, the Ministry of Water Resources released the Changjiang Water Resources Commission of the Ministry of Water Resources Measures for the Supervision and Management of River and Lake environment flow (for Trial Implementation), as well as the Guiding Principles and the Three-year Work Plan. These documents established flow protection targets for 171 key rivers and lakes that traverse provinces along the Yangtze River, and 307 key rivers and lakes within the provinces along the Yangtze River Basin. This represents a significant shift from fragmented to systematic management, from pilot programs to widespread implementation, and from target setting to "target setting + all-round supervision." At present, the supervision of flow in key rivers and lakes extends to all vital sections of the main channel and tributaries of the Yangtze River Basin.

Table 2-3: Key Measures for Environment Flow Monitoring and Management in the Yangtze River Basin

Measures Taken by the Changjiang Water Resources Commission to Implement the Yangtze River Protection Law and Strengthen the Monitoring and Management of Environment Flow in the Yangtze River Basin			
Issued the "Measures for Supervision and Management of River and Lake environment flow (Trial)".	It has determined the environment flow targets for 147 control sections of 86 inter-provincial rivers and key lakes including the Yangtze River, Hanjiang River, Jialing River, and formulated a plan to ensure implementation.	To strengthen environment flow regulation, a monitoring platform for environment flow in the Yangtze River Basin has been established. This platform enables real-time monitoring and dynamic regulation of environment flow, ensuring the effective safeguarding of environment flow conditions.	Strengthening the supervision of environment flow discharge, joint meetings are held with water administration authorities at all levels and water engineering operation management units to ensure environment flow discharge. Monthly and annually evaluations are conducted to ensure environment flow.

2.4 Impact and Response to Climate Change: Accelerator of Hydrological Cycle and Policy Response

Global climate change has accelerated the global hydrological cycle, resulting in more frequent and intense extreme weather events such as heavy rains, strong storm surges, and widespread droughts and floods. The Yangtze River Basin, located at the interface of warm and humid oceanic climate and continental climate, is particularly susceptible to the effects of subtropical high pressure. The Basin is therefore highly sensitive to the impacts of global climate change.

Since July 2022, the Western Pacific subtropical high has been larger and stronger, and the duration longer, with a position biased to the west and north. It has also lingered over the Yangtze River Basin. Controlled by the subsidence airflow of the subtropical high, cold air directly southward to the sea cannot affect the lower reaches of the Yangtze River, resulting in continuous high temperature and less rain over the entire basin. The inflow of the main rivers and lakes in the basin is significantly less, and the water level is significantly lower than previous periods. This has led to a rare drought situation. Typically, June is the rainy season in the Middle and Lower reaches of the Yangtze River Basin. However, since mid-June 2022, precipitation in the basin has gone from being excessive to insufficient, leading to an abnormal phenomenon – the very opposite of flooding that we often expect in this season – drought. According to statistics from relevant departments, since mid to late June, the overall precipitation in the Yangtze River Basin has been less than 40% of the same period in the previous years, and some areas have less than 80%, the lowest precipitation values for this same period since 1961. In August particularly, the precipitation of the Yangtze River Basin was less than 50mm, less than 60% relative to the same period in previous years. The duration of high temperature weather exceeded 30 days. In some areas, the high temperature weather lasted for more than 40 days.

In July 2022, based on considerations of the risk of droughts and floods, the Changjiang Water Resources Commission of the Ministry of Water Resources controlled thhe Three Gorges Reservoir and reservoirs for major tributaries such as the Yalong River, Jialing River, and Wu River. In addition, the Commission used controlled small and medium-sized flooding to help mitigate impacts for drought. For instance, release of 5 billion cubic meters provided sufficient water resources for people during the drought season. Other provinces including Hubei, Hunan, Jiangxi, and Anhui also made operations ahead of time to ensure sufficient water resources for drought relief and mitigation.

The drought in the Yangtze River Basin worsened in August. The Ministry of Water Resources and the provinces along the river collaborated on the water management plan. It aimed to alleviate the rapid decline of water levels in the Middle and Lower reaches of the Yangtze River and ensure water supply for irrigation along the river. These operations to ensure adequate water supply and provide some buffer from drought were launched on August 16th and September 12th respectively. The upper stream reservoir groups centered on the Three Gorges, the Dongting Lake basin, and the Poyang Lake basin to supply water to the regions in the lower reaches of the Yangtze River.

The Changjiang Water Resources Commission of the Ministry of Water Resources effectively coordinated various demands including power generation, shipping, and water supply to optimize the reservoirs. The Three Gorges Dam, Danjiangkou Dam, and other reservoirs were managed to cope with the extreme high temperature in the summer and ensure electricity supply during the peak demand. In collaboration with the shipping department, the Three Gorges ship lock achieved a record cargo volume of over 100 million tons from January to August. The operation also facilitated ship evacuation from drought in the Han River and Wu River.

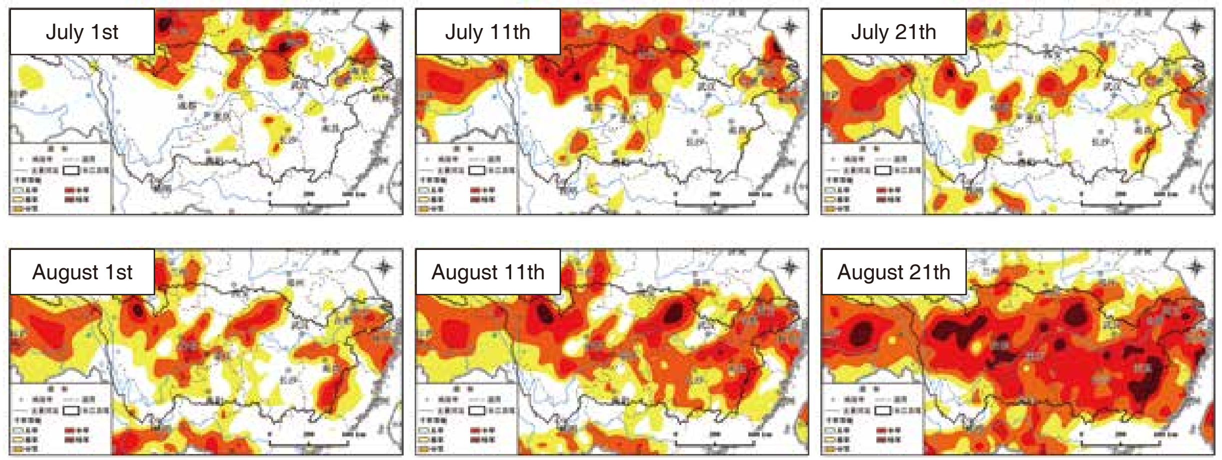


Fig.2-3 Spatial Distribution of the Drought Duration in the Yangtze River Basin, July-August, 2022

Chapter 3

Spatiotemporal Dynamics of the Water Quality Index

The strategic socioeconomic development of the Yangtze River Basin is closely tied to environmental issues. Analysis of the spatiotemporal dynamics of the water quality index highlights the need to establish an emergency mechanism to cope with emerging environmental pressures and strengthen pollution prevention and control measures.

Pheasant-tailed Jacana at Dongting Lake Wetland © Yao Yi / WWF

3.1 Water Quality Index of the Yangtze River Mainstem and "Four lakes”

Although the water quality of the mainstem of the Yangtze River has shown significantly improvement since the last report, the water quality indices of Chao Lake, Dongting Lake, and other water bodies have declined over this same span.

The calculation method for the water quality index of the Yangtze River mainstem in the 2022 Report is unchanged from the 2020 Report.

Water Quality Index of the Yangtze River Mainstem

In 2021, the water quality index for various sections of the Yangtze River mainstem was 1.13 for the Source section, 0.87 for the upper section, 0.71 for the middle section, and 0.73 for the lower section. A comparison of the baseline year (2018) reveals an improvement in the index, indicating a significant enhancement of the water quality of the Yangtze River mainstem (See Table 3-1).

Water Quality Index of the “Four Lakes

In 2021, the water quality indices of Dongting Lake, Poyang Lake, Taihu Lake and Chao Lake were 0.31, 0.33, 0.30 and 0.11, respectively. The water quality indices of both Taihu Lake and Poyang Lake showed an improvement since the 2020 Report. However, the water quality indices of both Chao Lake and Dongting Lake showed declines (see Table 3-1).

Table 3-1 Evaluation Results of Water Quality Index for Yangtze River Mainstem and "Four Lakes"

	Water Quality Index	Grade of Water Quality Index	Water Quality Index of 2020	Grade of 2020
Source of the Yangtze	1.13	A	1.00	A
Upper Yangtze	0.87	A-	0.75	B
Middle Yangtze	0.71	B	0.67	B-
Lower Yangtze	0.73	B	0.65	B-
Dongting Lake	0.31	D	0.34	D
Poyang Lake	0.33	D	0.32	D
Tai Lake	0.30	D	0.22	D-
Chao Lake	0.11	E	0.20	D-

3.2 Spatiotemporal Differences in Water Quality Index of the Yangtze River Mainstem and Four Lakes Region

In general, values of the water quality indices of the lakes and reservoirs of the Yangtze River Basin are lower compared to the main channel and tributaries of the basin.

In 2021, the water quality indices of various sections of the Yangtze River Basin showed that the Source of the Yangtze River, Yalong River, Wu River, and Qing River had high values, which exceeded the baseline value from the 2020 Report (based on 2018 data), with values of 1.13, 1.87, 1.35, and 2.04, respectively. However, the water quality indices of certain tributaries, such as Tuo River, Han River, and Xiang River, showed a decrease over this same period. Moreover, the water quality index values of lakes and reservoirs in the Yangtze River Basin were even lower than those of the tributaries. For instance, Chao Lake and Hong Lake had the lowest water quality indices with values of only 0.11 and 0.14, respectively (see Figure 3-1 and Figure 3-2).

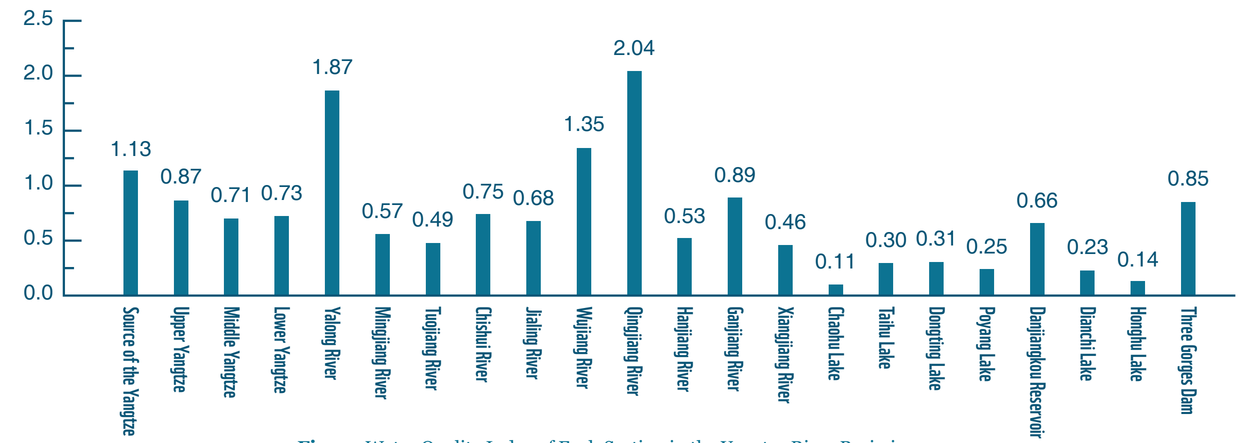


Fig.3-1 Water Quality Index of Each Section in the Yangtze River Basin in 2021.

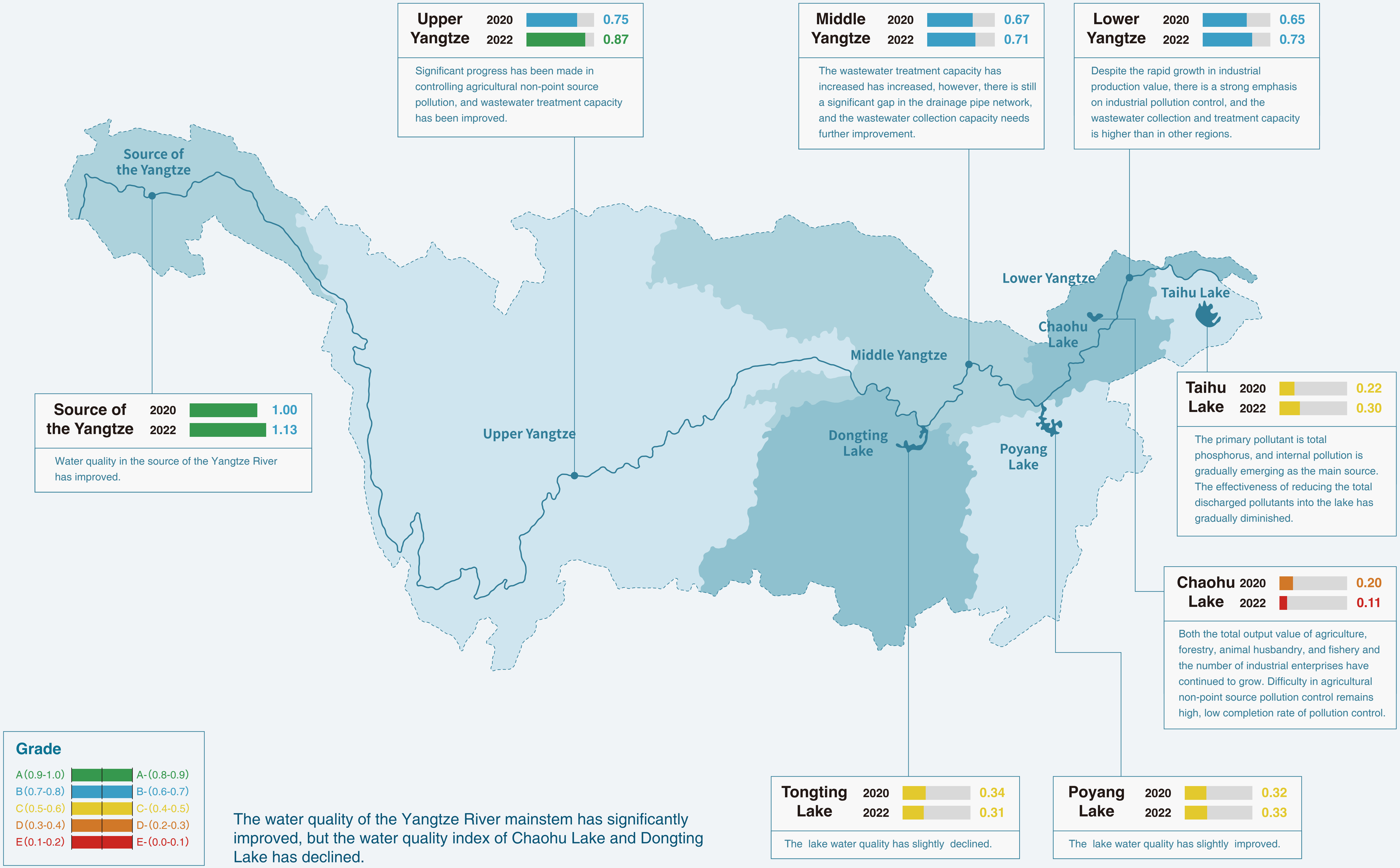


Fig.3-2 Spatiotemporal Changes in the Water Quality Index of the Yangtze River and "Four Lakes" in 2020 and 2022

3.3 Opportunities and Policy Responses for Mitigating Pressure on Water Environmental Policy and Actions on Mitigation of Environmental Pressures on Yangtze Water Resources

The continued emergence of contaminants has contributed to environmental pressures in Yangtze River aquatic environments. How do we deal with this?

Overall Changes in Environmental Pressures on Water

The implementation of the Yangtze River protection strategy, the “4+1 Pollution Treatment Project” led to solve many water-associated environment problems. The project encompasses urban sewage and garbage treatment, and control of pollution from chemical, agricultural, ship and tailing pond sources. The supervision of sewage outlets and tracing of wastewater discharge outlets have been especially effective. The centralized wastewater treatment facilities in cities along the mainstem has now achieved full coverage, while previously black and odorous water bodies in urban areas at or above the prefecture level have been basically eliminated.

Despite progress made in solving many environment problems related to water resources, the Yangtze River Basin still faces significant challenges. Non-point source pollution, which includes urban and agricultural non-point sources, is the most difficult to address. Although some progress has been made in reducing agricultural non-point source pollution, end-of-pipe treatment remains a challenge due to large amounts of nitrogen and phosphorus pollutants. It is thus urgent for governments and relevant agencies to promote further collaboration in addressing treatment challenges.

Intense demands from human economic activities have placed significant pressures on the water environment of the Yangtze River Basin.

In recent years, the Chinese government has made remarkable progress in controlling conventional pollutants in the Yangtze River Basin, leading to continuous improvement in water equality. However, new environmental problems associated with water are emerging. Mining activities and tailings dams in the Basin introduce risks to the ecology and to aquatic environments. The shipping industry generates pollution. With the development of economy and society, new contaminants and risks are also arising. Those aspects must be closely monitored and addressed to safeguard the environmental security of the Yangtze River for all people.

According to research, emerging contaminants may refer to persistent organic pollutants, environmental endocrine disruptors, pharmaceuticals and personal care products, microplastics, among other chemicals. The heavy chemical industry concentrated on the shores of the Yangtze River and its tributaries represents a significant risk for these emerging contaminants. Due to their biotoxicity, environmental persistence, and bioaccumulation, even small amounts of emerging contaminants may cause significant harm and pose high risks in both short- and long-term.

To address the issues of emerging contaminants, we suggest the immediate implementation of detection methods, establishment of environmental standards, and strengthening of pollutant emissions investigation procedures and monitoring. The government, relevant agencies, and research institutions should engage in research and establish emergency response plans to deal with the growing number of contaminants that pose risks to humans, to wildlife, and to the environment.


YUSHU, Qinghai Province- Longbao Wetland © Wei Baoyu / WWF

Column 1

Status of Emerging Contaminants in the Yangtze River Waterbodies

Emerging contaminants pose significant threats to the environment and human health due to their biotoxicity, environmental persistence, and bioaccumulation. This type of pollutants has not yet been fully addressed in environmental management, and existing management measures may not be sufficient.

In May 2022, The General Office of the State Council issued the Action Plan for the Control of Emerging Contaminants. The Plan aims to complete the environmental risk assessment of hemicals by 2025 and publish an up-to-date list of emerging contaminants under control. To address the issue, environmental risk control measures will be taken, including the banning, restricting, and limiting the discharge of these listed emerging contaminants.

Globally, there is no consensus on the classification of emerging contaminants, but they are commonly divided into several categories, including microplastics, pharmaceuticals and personal care products (PPCPs), polybrominated diphenyl ethers (PBDEs), per- and polyfluoralkyl substances (PFASs), drinking water disinfection by-products, and ‘other toxic substances.’

Emerging contaminants have been detected in varying concentrations in the water and sediments of the Yangtze River Basin.

Microplastics are a common type of emerging contaminant in the aquatic environment, and the abundance of microplastics in the Yangtze River Basin increases gradually from its Upper to Lower reaches. In most water bodies, microplastics show high abundance along the coasts and low abundance in the centers. A comparison with other river basins domestically and internationally indicates that the level of microplastic pollution in the Yangtze River Basin is medium to low.

Antibiotics have been detected at varying levels in the Yangtze River. Compared with other domestic and international water bodies, the overall level of sulfonamides in the Nanjing section of the Yangtze River is relatively low. Nineteen antibiotics were detected in the Yangtze River estuary, with a general trend of low concentrations in summer and high concentrations in winter.The concentration is higher near the confluence of rivers and the outfall of sewage treatment plants than at other locations.

PPCPs can be detected in sediments. At least 36 types of PPCPs have been detected in Taihu Lake, with concentrations in the water body typically in the nanograms per liter range. However, the concentrations in the sediments are much higher, reaching microgarms per liter. PPCPs monitoring in water bodies should be augmented.

PFASs are a class of persistent organic pollutants with adverse effects on the human body, including organ toxicity, neurotoxicity, immune and endocrine toxicity, reproductive and developmental toxicity, and carcinogenicity. PFASs have been widely tested for in the main channel, tributaries, and lakes of the Yangtze River Basin, with average concentrations lower than in other major river basins in China. Among the various PFASs, perfluorooctanoic acid (PFOA) has a higher environmental concentration in the Yangtze River Basin, while perfluorooctane sulfonic acid (PFOS) has decreased to very low levels in the past decade due to environmental control measures.

PBDEs are a class of organic brominated compounds widely used as flame retardants. Long-term exposure to low concentrations of PBDEs may cause neurobehavioral deficits and increases the risk of cancer. Currently, PBDE concentrations in water bodies and sediments in the middle and lower Yangtze River are higher than those in the upper reaches. The concentration of PBDEs in the muscle tissue of freshwater fish in the Yangtze River are at the ng/g levels, and the level of PBDE pollution in organisms is moderate compared to other regions worldwide.

In conclusion, various emerging contaminants have been detected at different concentrations in the Yangtze River, particularly in sediments. These pollution levels are a cause for concern. With the implementation of the Action Plan on Emerging Contaminants, provinces and municipalities have responded by developing policies and emergency response plans to regulate emerging contaminants monitoring. These efforts are expected to improve the pollution levels of emerging contaminants in the Yangtze River Basin.


Microplastics © Shutterstock / WWF


Microplastics © Shutterstock / WWF

Changes in Environmental Pressures on Waters in the Yangtze River Main Channel

The indicators of environment pressures on the aquatic systems in the upstream area are mainly the total output of agriculture, forestry, animal husbandry, and fisheries, as well as the the length of drainage pipes used in sewage treatment. Through analysis of relevant data on such pressure indicators in Sichuan Province and Chongqing City in recent years, we found that the total output of agriculture, forestry, animal husbandry, and fishery in both places has consistently increased yearly. This increase may have contributed to the deterioration of water quality in 2019. However, the length of drainage pipes in both places has also increased by 26.5% in 2020 compared to 2018, indicating an improvement in sewage treatment capacity, which helped improve water quality from 2020 to 2021.

In recent years, Sichuan and Chongqing have made significant progress in treating agricultural non-point source pollution. Despite the yearly increase in the total output of agriculture, forestry, animal husbandry and fisheries in the upstream area, the use of fertilizers that causes agricultural non-point source pollution has gradually decreased. Moreover, the length and density of sewage drainage pipes, as well as wastewater treatment rate, has steadily increased in the upstream area. These improvements in reducing non-point source pollution pressure and increasing sewage treatment capacity have been the primary reasons for the significant improvement in the water quality index in the past two years.

The main indicator of environment pressures on the waters of the middle reaches of Yangtze River is the total amount of sewage treatment. From 2018 to 2020, the capacity of sewage treatment in Hubei, Hunan, and Jiangxi provinces, within the middle Yangtze River section, has steadily increased. In 2019, there was a 10.3% increase compared to 2018, followed by a 6.8% increase in 2020. "Urban sewage and garbage treatment" is a crucial component of the "4+1" project in the Yangtze River Economic Belt. There is still a significant need for enhancement in the sewage collection capacity within the middle Yangtze River. The density of drainage pipeline is notably lower in this region compared to both upper and lower regions. In 2019 and 2020, although water resources in the middle Yangtze River increased compared to 2018, water quality declined in 2019, and the improvement in water quality in 2020 was not significant. Our analysis reveals that the insufficient drainage pipeline network has led to the decline of water quality. Improving sewage collection capacity is crucial to enhancing water quality in the middle Yangtze River.

The main indicators of environmental pressures on the waters of the downstream area of the Yangtze River are total industrial production and the total amount of sewage treatment. Compared to the upstream and middle sections, the downstream section of the Yangtze River faces greater industrial pollution pressure, especially chemical pollution. By the end of 2020, over 8,000 chemical industries along the river were regulated. For instance, in Jiangsu Province, the province closed and stopped 4,454 chemical businesses, reducing the total number from nearly 7,000 to 2,341, thus with a total reduction of about 65% from 2016 to 2020. The number of chemical parks was reduced from 54 to 29, with a reduction of 46% from 2016 to 2020. In 2020, the operating income of the petroleum and chemical industry dropped to 54% of 2016 values. Although total industrial production has continued to grow in recent years, the growth rate in 2020 was less. Despite industrial production still putting pressure on the aquatic environment, the ability to control industrial pollution is strong. Moreover, the capacity for sewage collection and treatment is higher than other regions (see Figures 3-4 and 3-5 for details). These are the primary reasons for the improvement of the water environment in the downstream section of the Yangtze River.

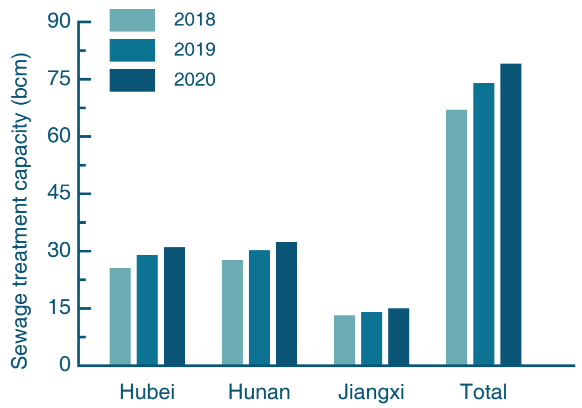


Figure 3-3 Changes in sewage treatment capacity inHubei , Hunan, and Jiangxi (2018-2020)

Figure 3-4 Changes in sewage treatmentcapacity in Anhui , Jiangsu , and Shanghai(2018-2020)

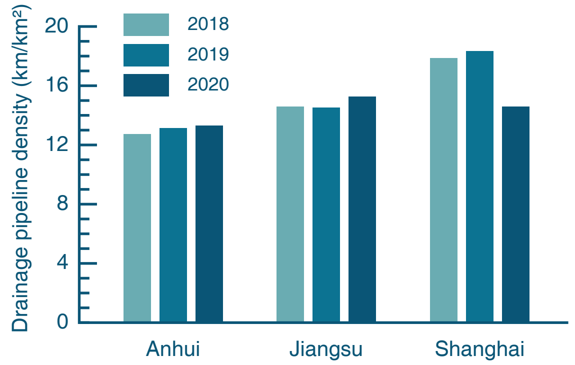


Figure 3-5 Changes in drainage pipeline densityin Anhui, Jiangsu, and shanghai (2018-2020)

Hubei Tian'e Zhou Oxbow nature reserve © Staffan Widstrand / WWF

Changes in the Environment Pressures of the Yangtze Tributaries, Lakes, and Reservoirs

From 2018 to 2021, the water quality index of the Chishui River decreased and then slightly increased. In recent years, the total output of of agriculture, forestry, animal husbandry, and fishery, the output from aquaculture, total industrial production, the amount of industrial wastewater discharged and domestic sewage discharge in the downstream section of Chishui River have all increased significantly. Notably, the total output of agriculture, forestry, and animal husbandry increased by 17.4% in 2020 alone.

The Chishui River, as a tributary of the Yangtze River, is under significant pressure from agricultural non-point source pollution, industrial pollution, and urban domestic pollution. Unfortunately, sewage collection capacity is much lower than in other areas of the Yangtze River Economic Belt, which is the primary reason for the decline in water quality. As a result, the Chishui River faces significant challenges in maintaining a healthy aquatic environment.

From 2019 to 2021, the water quality index of the Xiangjiang River, a tributary of the Yangtze River, continued to decline. Similar to the Chishui River, the Xiangjiang River Basin is under significant pressure due to agricultural non-point source pollution, industrial pollution, and urban domestic pollution. In recent years, there has been a significant increase in the total output of agriculture, forestry, animal husbandry, and fisheries, while the annual growth rate in urban domestic sewage discharges reached about 10%. Unfortunately, the density of sewage drainage networks in Hunan Province is the second-lowest among the 11 provinces and municipalities of the Yangtze River Economic Belt, only slightly higher than the Guizhou Province. The inadequate capacity for sewage collection and treatment has led to significant pressure on aquatic environments and a continuous decline in the water quality in the Xiangjiang River.

The environmental pressures faced by the Chishui River and Xiangjiang River are similar. Both rivers face challenges related to agricultural non-point source pollution, industrial pollution, and urban domestic pollution, leading to a continuous degradation of water quality. In addition, the density of sewage drainage network is low in both areas. It is unlikely that sewage collection capacity will improve significantly in the short term.

Agricultural non-point source pollution is the primary source affecting aquatic environments of Chaohu Lake and Hong Lake. The water quality index of Chaohu Lake has fluctuated between 2018 and 2021, with an initial increase and subsequent decrease. Total phosphorus is the main indicator affecting their water quality indices of both water bodies. Agricultural non-point source pollution is the primary environmental pressure in the Chaohu Lake Basin followed by industrial pollution. The total output of agriculture, forestry, animal husbandry, and fisheries in the Chaohu Lake Basin continued to increase due to a decline in fertilizer use. However, the use of phosphorus fertilizer increased in 2020 due to the expansion of aquaculture and industrial production. The production of aquaculture in the basin has continued to grow, with growth rates of 8.6% and 5.3% in 2019 and 2020, respectively. The number of industrial enterprises in the Chaohu Lake Basin has also continued to increase, with growth rates of 9.9% and 14.4% in 2019 and 2020, respectively. Despite a constant decrease in the discharge of untreated wastewater, the total amount of industrial wastewater remains high, significantly impacting aquatic environments.

In October 2018, the Guiding Opinions on Accelerating the Treatment of Agricultural Non-point Source Pollution in the Yangtze River Economic Belt outlined the need to strengthen pollution treatment in key areas, with Chaohu Lake and other drainage areas identified as key treatment areas. The Guiding Opinions also proposed the implementation of detailed control targets and measures. However, the treatment of agricultural non-point source pollution remains challenging. With around 420,000 acres of agricultural irrigation areas around the Chaohu Lake, large amounts of fertilizer and pesticides are introduced into the lake. By the end of 2020, many tasks in the Implementation Plan for the Comprehensive Management of Chaohu Lake (issued by the Anhui Provincial Government at the end of 2018) were not yet completed, indicating that the Chaohu Lake's pollution control efforts still have a long way to go.

Similar to Chaohu Lake, from 2019 to 2021, the water quality index of Hong Lake experienced similar fluctuation with Chaohu Lake. The water quality of Hong Lake is worse than that of Chaohu Lake. Total phosphorus is the primary factor affecting water quality in the Honghu Basin. Agricultural non-point source pollution, especially aquaculture pollution, and urban domestic sewage are the main environmental pressures in the area. The gross output of agriculture, forestry, animal husbandry, and fisheries in the Hong Lake basin increased by 7.7% and 5.2% in 2019 and 2020, respectively. The aquaculture production in the basin is high, which has been increasing in recent years. Due to the surge in domestic sewage, the discharge of wastewater increased by 5.6% and 56.0% in 2019 and 2020, respectively. Approximately 60% of the lake area in Honghu was once occupied by enclosure aquaculture. While the removal of the enclosure aquaculture improved the water environment of Honghu to some extent, there is still much work to be done to reduce agricultural non-point source pollution and improve urban sewage capacity.

Column 2

Actions for Sustainable Management of Plastic Waste in the Yangtze River Delta

The conservation and high-quality economic development of the Yangtze River require improved hydrology, water quality, and aquatic biota. The greening and optimization of the Basin's economic and social operations can help achieve these goals. Solid waste pollution in the Yangtze River Basin affects the water quality in the middle and lower reaches of the river, as well as coastal areas. Therefore, exploring sustainable solid waste management in the basin is crucial to improve water quality and increase the Living Yangtze Index.

China has a long-standing history of incorporating plastic pollution control into its framework for sustainable solid waste management. In September 2021, the Office of the National Leading Group for Promoting the Development of the Yangtze River Economic Belt of China issued the 14th Five-Year Plan for Plastic Pollution Control in the Yangtze River Economic Belt. The Plan aims to strengthen the the control of plastic pollution in the area by cleaning up floating and shoreline plastic garbage, enhancing the cleaning and transport of plastic garbage in ships and ports, and establishing long-term management for the disposal of agricultural plastic waste. The efforts are expected to reduce the direct impact of plastic pollutants. WWF is committed to developing systematic disposal programs that align with the official efforts to manage plastic pollution in the Yangtze River Basin. WWF recognizes the challenges associated with implementing the plans, as well society's demands for high-quality resuable plastic items.

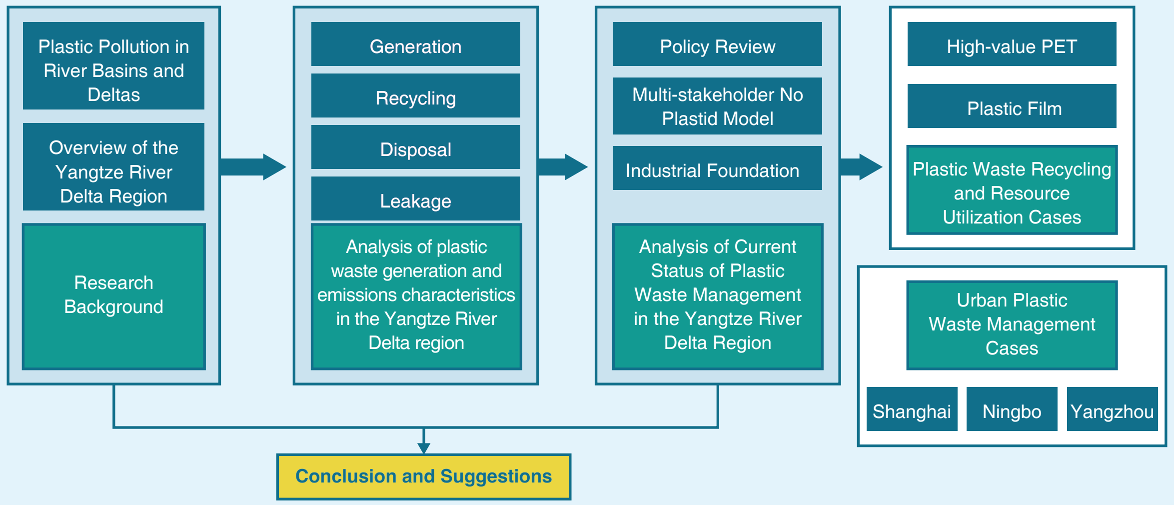
While plastic reduction actions have been in place for many years, metrics to evaluate their efficacy are not clear, making it hard to undertake statistical evaluation. For instance, initiatives such as "No Waste City" and "Plastic Smart City" have not been incorperated, and municipal and industrial statistical data have not been integrated into our evaluations. The complete data from the plastic waste industry, including production, sales, consumption, disposal, recycling, and resource utilization, are not systematically collected, and the data that have been collected are neither comprehensive nor accurate. Moreover, the data for low-value waste materials are often not collected at all.

The recycling rate of PET bottles in China ranges from 83% to 95%, but the statistical methods and metrics used to measure this vary significantly in China and abroad. Although China has made progress in recycling PET bottles and other plastic waste, effective reuse and high-quality recycling of plastic waste are still in their early stages. Even in the Yangtze River Delta region, where many excellent waste classification and recycling practices have been implemented, corporations involved in waste classification and recycling face challenges due to insufficient waste collection systems.

The Yangtze River Delta region ranks among the top ten in China for the total amount of plastic production, imported plastic waste, plastic waste generation, and recycling. The delta region has been the key region for implementing the policies incluenced by the central government, including plastic reduction, as well as the recycling and reuse of waste plastic. The delta region is well-positioned to make significant progress in addressing plastic pollution.

To enhance the sustainable management capacity of plastic waste in the Yangtze River Delta region, the 2022 Report team conducted a comprehensive analysis of particular case studies, examining the effectiveness in contributing to plastic pollution control in China. Through an in-depth analysis of typical cases along the entire industrial chain, the team identified areas where plastic leakage occurs, providing valuable insights for planning future reduction efforts and exploring high-quality recycling waste. The team also conducted research on the waste generation and migration patterns of plastic waste, evaluated the potential for high-quality recycling of plastic waste, and studied ways to promote the "No Plastic" system around the Yangtze River region and to encourage the participation and actions from both the users and producers. In addition, the team proposed recommendations for data collection and the establishment of a systemic regulation system.

This report aims to provide the public with a comprehensive understanding of the current situation of solid waste management, with a particular focus on sustainable management of plastic waste. The public will not only learn about the achievements of the waste management initiative, but this report will also increase the awareness of the difficulties and challenges. By advocating for the cooperation of government, industry, municipal works, and public participation, this report seeks to promote the pioneering role of the Yangtze River Delta's 'No Plastic' initiative and its sustainable management of plastic waste.



Chapter 4

Spatiotemporal Dynamics of Aquatic Biota Index

The health of the aquatic biota overall in the Yangtze River Basin can be assessed by observing the living conditions of fish. The reproduction, survival, and diversity of fish populations served as indicators of the overall health of the aquatic biota in the Yangtze River Basin. While the the "Ten Year Fishing Ban" has been implemented to address some of the issues, there remain challenges that need to be addressed and opportunities for further exploration in this area.

Sanjiangyuan Wetlands - Tibetan Antelope © Wei Baoyu / WWF

4.1 Aquatic Biota Index of the Yangtze River Main Channel and "Four Lakes"

Evaluation to estimate the aquatic biota index evaluation included estimating the number of fish species, finless porpoise population size, and abundance of fish larvae. The number of fish species in the middle and lower reaches of the Yangtze River has increased, mainly due to the increase in both the number of fish species and in the abundance of fish larvae.

Overview of the Yangtze River Aquatic Biota Index

In contrast to the 2020 Report, the 2022 Report has removed the indicator of natural fisheries production Reflecting the evaluation principles of sustainability, availability, and bioindicator, the 2022 Report selected three indicators, including the number of fish species, the population size of the Yangtze finless porpoises, and abundance of fish larvae to fully evaluate the Aquatic Biota Index of the Yangtze River (see Table 4-1 for details). By focusing on these indicators, the report provides a more holistic reflection of the biodiversity and ecosystem services of the river ecosystem, and assess the overall health status of Yangtze River ecosystems.

Habitat indicators are an important element in evaluating the status of aquatic biota. The evaluation of habitat indicators based on remote sensing images from a single year can lead to deviations when evaluating images from different seasons; e.g. the remote sensing images of the wet seasons (July-August) and the dry seasons (December-January next year) in 1987 and 2020, respectively. Therefore, the evaluation of habitat indicators in the river mainstem area can only be used as a reference. Consequently, the 2022 Report did not consider the habitat indicators in the calculation of the Living Yangtze Index.

Table 4-1 Evaluation Indicator System for Aquatic Biota Index of the Yangtze River Main Channel

Indicator system level	Evaluation object	Evaluation indicators	Indicator meanings
Aquatic Organisms Status	Fish	The number of species	Species diversity
		Abundance of fish larvae	Fish larvae resource status
	Yangtze finless porpoise	Abundance of fish larvae	Population size

(Note: Number of species: including the total number of species, number of endemic species, and number of threatened species.)

Table 4-2 Evaluation Indicator System for LYI of Four Freshwater Lakes in the Yangtze River Basin

Indicator system level	Evaluation object	Evaluation indicators	Indicator meanings
Aquatic Organisms Status	Yangtze finless porpoise	population size	population size
		Total number of taxonomic units	Abundance of aquatic biota
	Fish	Total number of taxonomic units	Structure of dominant species
	Macroinvertebrates	(Crustaceans and Bivalvia) % Berger-Parker index**	Abundance of aquatic biota
		Diversity index	Biodiversity status
		FBI index	Pollution tolerance
	Phytoplankton	Total number of taxonomic units	Abundance of biological groups
		Percentage of blue-green algae density	Structure of typical biological groups
		Percentage of dominant biological groups	Dominance of a single biological group
		Diversity index	Biodiversity status

(Note: Number of species: including the total number of species, number of endemic species, and number of threatened species.)

Aquatic Biota Index of the Yangtze River Mainstem

Based on the Source of the Yangtze River as a reference, the comprehensive indicator evaluation of the Yangtze River main channel showed that the upper, middle, and lower reaches of the river scored 0.64, 0.44, and 0.65 respectively. The upper and lower reaches were graded B minus, while the middle reach was graded C minus (see Table 4-3 for details).

Table 4-3 The Aquatic Biota Index Evaluation Results of the Yangtze River Mainstem.

	The Aquatic Biota Index of the Yangtze River mainstem.					Aquatic Biota Index	Grade of Aquatic Biota Index	2020	Grade of 2020
	Number of species	Number of endemic species	Number of threatened species	Number of Yangtze finless porpoise population	Abundance of fish larvae				
Source of the Yangtze	1.00	1.00	1.00			1.00	A	1.00	A
Upper Yangtze	0.72	0.72	0.49			0.64	B-	0.64	B-
Middle Yangtze	0.64	0.58	0.31	0.22	0.45	0.44	C-	0.38	D
Lower Yangtze	0.65	0.83	0.88	0.24		0.65	B-	0.58	C

(Note: The finless porpoises in the source and upper reaches of the Yangtze River, as well as the early resources in the source, upper, and lower reaches of the Yangtze River were not evaluated.)

• Changes in the Number of Fish Species, Endemic Species, and Threatened Species in the Yangtze River Mainstem

In the 2022 Report, the score for the number of fish species in the upper reaches of the Yangtze River mainstem increased from 0,71 to 0.72 in the 2022 Report due to the presence of the invasive species of Ameiurus nebulosus. In the middle reaches, the score increased from 0.63 to 0.64, with the addition of Ochetobius elongatus. The score for the number of fish species in the downstream area also increased from 0.64 to 0.65, because of the presence of Ochetobius elongatus. There were no changes in the number of endemic or threatened species in each section of the river.

• The Spatiotemporal Changes of Fish Larvae Resources in the Yangtze River Main Channel

Overall, the abundance of fish larvae in the Yangtze River has increased. Specifically, at the Jianli cross-section in the middle reach of the mainstem Yangtze River, the evaluation results for the larvae of the four major Chinese carp species reveal a score of 0.45 with a grade of C, which is markedly higher than the score of 0.14 in the 2020 Report. In addition to the middle reaches of the Yangtze River, the number of fish larvae has also increased in the Jiangjin section of the upper reach and the Anqing section of the lower reach.

• The Spatiotemporal Changes in the Yangtze Finless Porpoise Population

In general, the finless porpoise population in the Yangtze River mainstem has shown a trend of recovery. The population has increased from 445 individuals in 2017 to 595 individuals in 2022. Specifically, the evaluation score for the finless porpoise in the middle reaches of the Yangtze River has increased from 0.21 in the 2020 Report to 0.22 in the current report, an increase of 0.01. The evaluation score for the finless porpoise in the lower reaches of the Yangtze River has increased from 0.15 in the 2020 Report to 0.24, an increase of 0.09.

Three Gorges © Michel Gunther / WWF

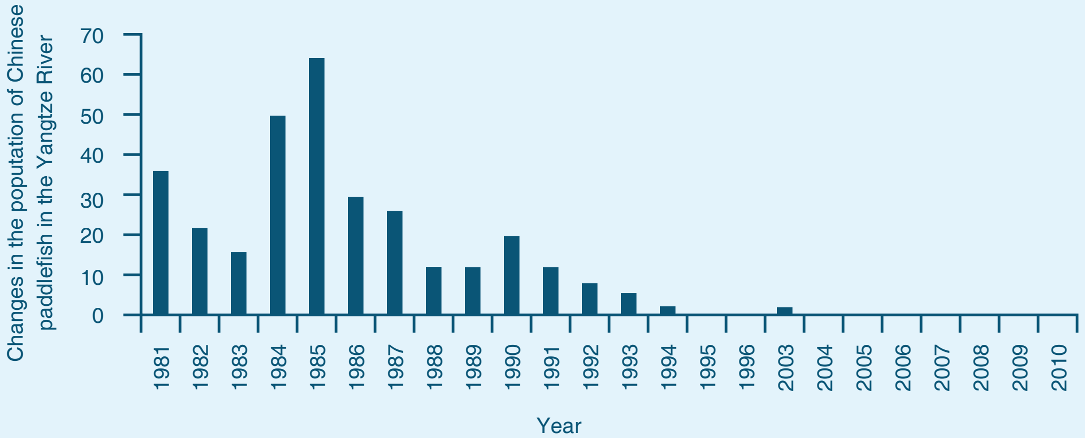
Column 3

The Chinese Paddlefish Declared Extinct

The Chinese paddlefish *(Psephurus gladius)* is a large predatory freshwater fish that inhabits the Yangtze River and belongs to the family Polyodontidae. It is endemic to China and is known as the largest freshwater fish in the country. The fish can grow up to 2-3 meters in length and weigh between 200-300 kilograms, with the largest individuals reaching up to 7.5 meters in length. Due to its snout resembling an elephant's trunk, it is also referred to as the elephant fish or the Chinese swordfish. The American paddlefish *(Polyodon spathula)*, which is found in the Mississippi River, belongs to the same family.

The Chinese paddlefish typically spawns upstream during the spring and primarily inhabit the main channel and tributaries of the Yangtze River from Yibin to the Yangtze River estuary, as well as the Qiantang River and the lower reaches of the Yellow River. This rare and precious Chinese endemic animal is listed as the National First-Class Protected Wildlife, and is often referred to as the "giant panda of the water".

The Chinese paddlefish (see Figure 1) has not been sighted since 2003. On July 21, 2022, the International Union for Conservation of Nature and Natural Resources (IUCN) released an updated report on the Red List of Threatened Species, officially declaring the extinction of the Chinese paddlefish.



Aquatic Biota Index of the Four Lakes region in Yangtze River Basin

• Aquatic Organisms Integrity Evaluation Results

Based on our evaluation of comprehensive indicators for the status of aquatic biota, Dongting Lake, Poyang Lake, Chaohu Lake, and Taihu Lake scored 0.65, 0.67, 0.38, and 0.53, respectively. Dongting Lake and Poyang Lake were rated "good", Chaohu Lake was rated "poor", and Taihu Lake was rated "fair". The grades assigned were B minus for Dongting Lake and Poyang Lake, D for Chaohu Lake, and C for Taihu Lake (see Table 4-4 for details).

Compared with the results in 2020, the scores and grades of Dongting Lake, Poyang Lake, and Chaohu Lake remained unchanged. The evaluation score of Taihu Lake showed a significant increase.

The main reason for the improvement of biomes and diversity in Taihu Lake was an increase in the diversity of phytoplankton and the number of macroinvertebrates.

Overall, the aquatic biota of the four lakes has remained stable and even, at least in once instance, improved. However, it should be noted that some indicators have shown a decline, indicating that the results are not entirely optimistic.

• Phytoplankton Integrity Evaluation Results

Phytoplankton integrity evaluation resulted in scores of 0.54, 0.61, 0.36, and 0.43 for Dongting Lake, Poyang Lake, Chaohu Lake, and Taihu Lake, respectively. Dongting Lake, Poyang Lake, and Taihu Lake were rated as "medium," while Chaohu Lake was rated as "poor."

Compared with the evaluation results of 2020, the score and rating of Dongting Lake have decreased, mainly due to the significant increase in the proportion and density of regional cyanobacteria. In contrast, the scores of Chaohu Lake and Taihu Lake have improved. Especially noteworthy is the increase for Taihu Lake as it is attributed to the increase in phytoplankton diversity.

• Macroinvertebrates Integrity Evaluation Results

Our evaluations of macroinvertebrates resulted in scores of 0.60, 0.63, 0.32, and 0.63 for of Dongting Lake, Poyang Lake, Chaohu Lake, and Taihu Lake respectively. While Chaohu Lake was rated as "poor," the other three lakes were rated as "good."

Compared to 2020, the evaluation score of Chaohu Lake has decreased while Taihu Lake has improved. This improvement in Taihu Lake can be attributed to an increase in the number of species.

• The Number of Fish Species

Our evaluation of fish species resulted in scores of 0.65, 0.58, 0.47, and 0.55 for Dongting Lake, Poyang Lake, Chaohu Lake, and Taihu Lake, respectively. Dongting Lake was rated as "good," while Poyang Lake, Chaohu Lake, and Taihu Lake were rated as "medium."

Compared to the 2020, the evaluation score of Poyang Lake saw a slightly increase, and the number of fish species has increased by 6 species (4%).

• Finless Porpoise Population

The evaluation results for the Yangtze finless porpoise reveal that Dongting Lake and Poyang Lake scored 0.82 and 1.0 respectively, indicating an excellent rating. The evaluation score and grade for Dongting Lake finless porpoises have significantly increased. In 2022, the number of Yangtze finless porpoises in the two lakes had decreased to 162 and 492. Compared to 2017, the number of finless porpoises in Dongting Lake increased by 52, while Poyang Lake saw an increase of 35.

Table 4-4 The Aquatic Biota Index Evaluation Results of major lakes in the Yangtze River

	Aquatic organisms integrity				Aquatic Biota Index	Grade of Aquatic Biota Index	2020 report	Grade of 2020 report
	Phytoplankton	Macroinvertebrates	Fish	Finless porpoise				
Dongting Lake	0.54	0.60	0.65	0.82	0.65	B-	0.61	B-
Poyang Lake	0.61	0.63	0.58	1.00	0.67	B-	0.66	B-
Tai Lake	0.43	0.63	0.55	-*	0.53	C	0.47	C-
Chao Lake	0.36	0.32	0.47	-*	0.38	D	0.37	D

(Note: The population of Yangtze finless porpoises in Taihu Lake and Chaohu Lake was not evaluated due to their isolation from the Yangtze River.)

Yangtze Finless porpoise © Michel Gunther / WWF

Black-necked Crane © Lei Jinyu / WWF

Typical River Sections and Habitat Restoration in the Yangtze River Basin

Research shows that there has been an improvement in habitat quality for aquatic species in the typical river sections and the Four Lakes region, with Dongting Lake, Poyang Lake, Chaohu Lake, and Taihu Lake scoring 0.55, 0.62, 0.25, and 0.37 respectively. Compared to 2020, Chaohu Lake shows a slight decline, while the other three lakes have slightly improved. In the evaluation year, there was an improvement in water quality in Poyang Lake and Taihu Lake. Notably, the vegetation coverage of the riparian zone has increased.

The restoration of shoreline in typical sections of the Yangtze River Basin has been effective, but there is still a need to strengthen the natural restoration of the floodplain area.

The Yangtze River shoreline is a crucial resource for the high-quality development of the Yangtze River Economic Belt. It is important for the overall planning of the industrial spatial layout of the Yangtze River Economic Belt, and is a focal point for the spatial control of the entire basin. To achieve the national strategy of the Yangtze River Economic Belt, maintain stable river regimes and flood control, supply water and shipping, and ensure environmental integrity, it is necessary to coordinate the development, utilization, and protection of Yangtze River shoreline resources. This can be achieved through scientifically-informed development of Yangtze River shoreline resources and implementation of effective legal protection and management.

The Yangtze River main channel is known as the "Golden Waterway" because of its navigability and ability to allow transport of goods. Since 2018, the Ministry of Water Resources, together with relevant bureaus, has supervised the removal of shoreline industries and rehabilitation in nine provinces and municipalities along the Yangtze River. The river and lake chief system and territorial responsibilities have been clearly defined, and supervision has been strengthened, using information technology to ensure the effective rehabilitation. As of October 2020, 2,414 illegal projects have been cleared, with a completion rate of 98.9%. A total of 158 kilometers of Yangtze River shoreline has been vacated, 2.34 million square meters of illegal buildings within the river channel management scope have been demolished, 9.56 million cubic meters of waste soil have been removed, and 12.13 million square meters of beach and shorelines have been restored. The connectivity of the shoreline situation in the Yangtze River mainstem has been improved, and the environment has been effectively restored with effective flood control, resulting in ecological, and social benefits. The appropriation of the Yangtze River shoreline for illegal development has been effectively curbed, creating a positive social environment for protecting the Yangtze River shoreline.

It is important to note that the natural recovery of the shoreline in the Yangtze River is still insufficient. Although some illegal docks (shown in Figures 4-1, 4-2, 4-3, and 4-4) have been transformed into parks, further efforts are needed to promote the natural restoration of the floodplain that plays an important role in restoring aquatic biodiversity.

Figure 4-1 Demolition of illegal wharf in Yibin, Sichuan

Figure 4-2 Demolition of industrial park along the coast in Yichang, Hubei

Figure 4-3 Clearing and restoration of vegetation on illegal wharf in Wuhu, Anhui

Figure 4-4 Rectification of illegal wharfin Nanjing, Jiangsu.

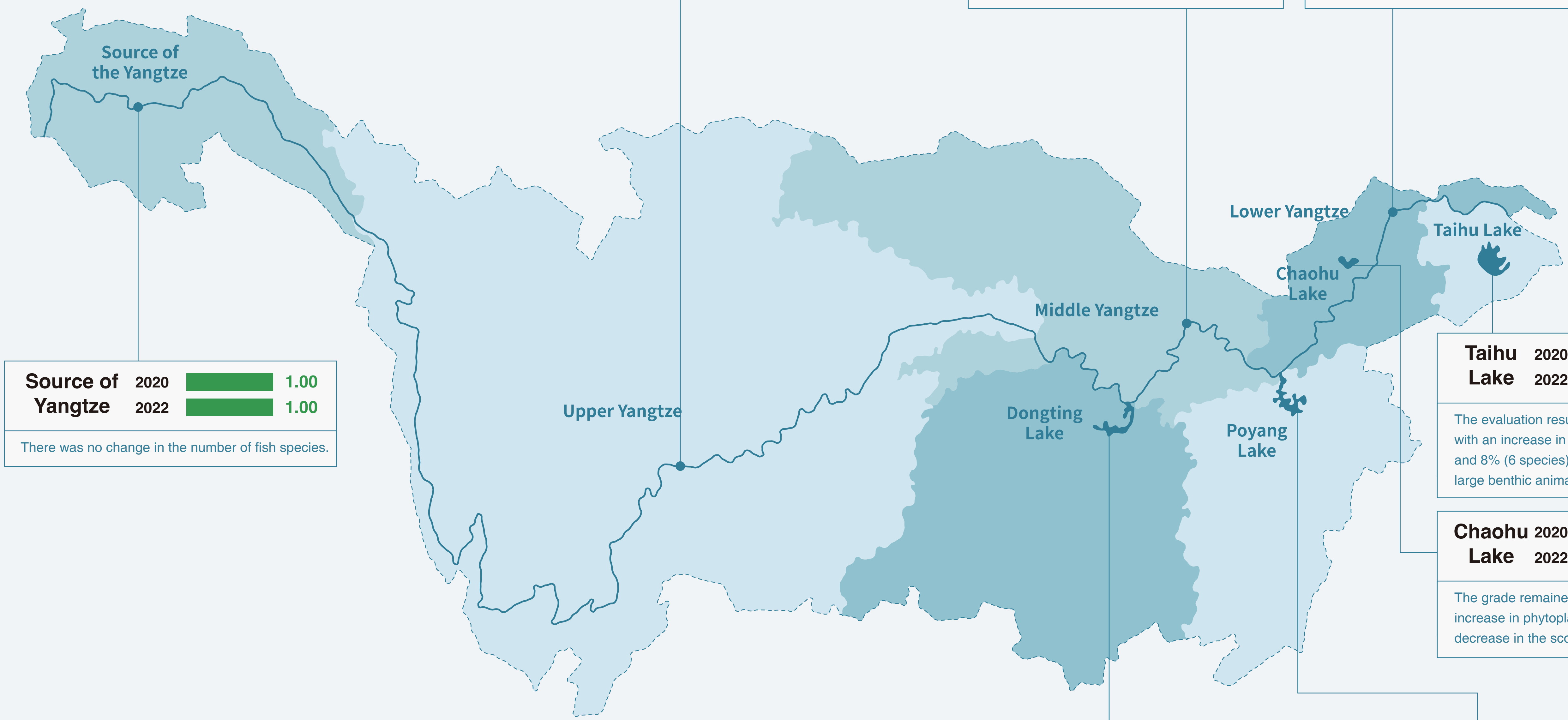
4.2 Spatiotemporal Differences in the Aquatic Biota Index of the Yangtze River Mainstem and the Four Lakes Region

The aquatic biota index of the Yangtze River main channel and the aquatic biota indices of the Four Lakes region has shown slight increases in value, primarily due to increases in the number of fish species, the abundance of fish larvae, and the population of Yangtze River finless porpoises.

The Yangtze River source serves as a reference for the health indicators as it has limited human interference. As of the 2022 Report, the Yangtze River main channel comprehensive aquatic biota index scored 0.68, indicating an increase of 0.02 from 0.66 as of the 2020 Report. The upper reaches of the Yangtze River remained unchanged, while the middle reaches showed an increase of 0.06 from 0.38 in 2020 to 0.44, and the lower reaches increased by 0.07 from 0.58 in 2020 to 0.65 (for detailed evaluation data, see Figure 4-5). The increases in the number of fish species, the abundance of fish larvae, and the population of Yangtze finless porpoises are the main reasons for the changes. In addition, the aquatic biota index of the major lakes in the Yangtze River has slightly improved compared to the previous period.

According to data released by relevant departments, the biodiversity of aquatic organisms in the Yangtze River is gradually recovering. First, the number of fish species and their population numbers are increasing. In 2022, 193 fish species were detected and monitored in the key water areas of the Yangtze River Basin, which is an increase of 25 species compared to 2020. The observation of rare species like Ochetobius elongatus in the wild increased. Second, estimates of larbal densities for the four major Chinese carp species in the middle reaches of the Yangtze River reached 7.87 billion, 4.83 times higher than in 2020. Last, the population of Yangtze finless porpoises has increased. According to the scientific expedition organized by the Ministry of Agriculture and Rural Affairs in 2022, the total population of Yangtze finless porpoises is 1,249, an increase of 23.42% over the past five years. The recovering of biodiversity is attributable to a wide range of policies. Prior to the implementation of the official global ban on fishing, some river sections had already been designated as conservation areas with a comprehensive ban on commercial fishing activities. Water flow was regulated to help to stimulate fish reproduction. In terms of water quality and habitat, many illegal and irregular docks were demolished, and management of sewage discharge along the Yangtze River was enhanced. These policies greatly reduced the pressure on the survival and reproduction of fish and promoted the recovery of aquatic biodiversity in the mainstem of the Yangtze River.

Dongting Lake © Audra Melton / WWF



Source of Yangtze — 2020: 1.00; 2022: 1.00

There was no change in the number of fish species.

Upper Yangtze — 2020: 0.64; 2022: 0.64

There was no change in the number of fish species.

Middle Yangtze — 2020: 0.38; 2022: 0.44

The number of fish species increased, and the resources of the four major Chinese carps larvae increased.

Lower Yangtze — 2020: 0.58; 2022: 0.65

The number of fish species increased, and the population of Yangtze finless porpoises increased.

Taihu Lake — 2020: 0.47; 2022: 0.53

The evaluation result increased from C- to C, with an increase in phytoplankton diversity and 8% (6 species)increase in the number of large benthic animal species.

Chaohu Lake — 2020: 0.37; 2022: 0.38

The grade remained unchanged, with an increase in phytoplankton score and a decrease in the score of macroinvertebrates.

Dongting Lake — 2020: 0.61; 2022: 0.65

The grade remained unchanged, with a decrease in phytoplankton score and an increase in the proportion of cyanobacteria.

Poyang Lake — 2020: 0.66; 2022: 0.67

The grade remained unchanged, with an increase of 4% (6 species) in the number of fish species and an increase in fish species score.

Grade

A (0.9-1.0)	A- (0.8-0.9)
B (0.7-0.8)	B- (0.6-0.7)
C (0.5-0.6)	C- (0.4-0.5)
D (0.3-0.4)	D- (0.2-0.3)
E (0.1-0.2)	E- (0.0-0.1)

The aquatic biota index of the Yangtze River main stream showed an upward trend, and the Aquatic Biota index of the "Four Lakes" slightly increased, with the evaluation grade remaining basically unchanged.

Figure 4-5 Spatiotemporal Differences in the Aquatic Biota index of theYangtze River Mainstem and the "Four Lakes"

Column 4

The Results of a Leading Pilot Study from the Chishui River – a Ten-year Fishing Ban

On January 1, 2017, the Chishui River Basin was selected as a national pilot area for the implementation of the fishing ban, which provided valuable insights for the comprehensive fishing ban in the Yangtze River Basin. The evaluation of the fishing ban effects in the Chishui River can be used to predict the effectiveness of the fishing ban in the Yangtze River.

1.Existed Problems before the Fishing Ban

• Reduction in size of fish in fishers catches: the proportion of larger-sized fish in fishers' catches, such as *Spinibarbus sinensis* and *Onychostoma* sima, gradually decreased, while the proportion of small-sized fish in the catch, such as *Hemibarbus labeo*, *Squalidus argentatus*, and *Rhinogobius giurinus*, *sharply increased*.

• Populations of endemic fish species, such as *Hemiculter tchangi* and *Coreius guichenoti*, experienced a severe decline, with the latter showing the most striking decline.

• The frequency of invasive species such as *Ictalurus punctatus* and *Ameiurus nebulosus*, in fishers catches increased.

• During field sampling, some rare species, such as *Psephurus gladius*, *Anguilla japonica*, *Luciobrama macrocephalus*, and *Ochetobius elongatus*, were no longer present.

2.Changes in the Chishui River After the Fishing Ban

• Increase of Endemic Fish Species: the number of endemic fish species caught in the main channel sections increased to 22.7 species. Native fishes such as *Xenocypris microlepis*, *Xenophysogobio boulengeri* and *Percocypris pingi*, which had been absent for many years, were re-discovered in the monitored river sections.

• Recovery of Rare Fish Resources: The capture of two National Key Protected Wild Animals, the Chinese sturgeon and *Myxocyprinus asiaticus*, significantly increased. The capture rates of the Chinese sturgeon rose from 0.1/year before the fishing ban to 3.0/year, while the capture rates of the *Myxocyprinus asiaticus* rose from 3.4/year before the fishing ban to 5.7/year.

• Changes in Fish Populations: average weight of *Spinibarbus sinensis* increased from 336.9g to 492.5g, and average weight of *Onychostoma sima* increased from 315.9g to 479.8g. The trend of younger age and smaller body sizes of fish populations was effectively controlled.

• Significant Improvement of Fish Habitat and Breeding Conditions: in 2018, breeding activity of C*tenopharyngodon idella* was detected for the first time in the Chishui River, indicating an improvement in the habitat. The population of *Spinibarbus sinensis* also showed a significant increase in numbers of eggs and larvae. The number of larval fish species found in our field investigations increased from 32 before the fishing ban to 37, implying that the overall fish biodiversity in the Chichui River has improved.

• Significant Increase in Resource Abundance: single-vessel monitoring yield increased after the implementation of the fishing ban. The average daily monitoring capture using gillnets increased from 4.1kg to 8.0kg, and the monitoring yield using small hook capture methods increased from 4.1kg to 8.5kg (details on http://www.cjyzbgs.moa.gov.cn).

© Liu Yiyang / WWF

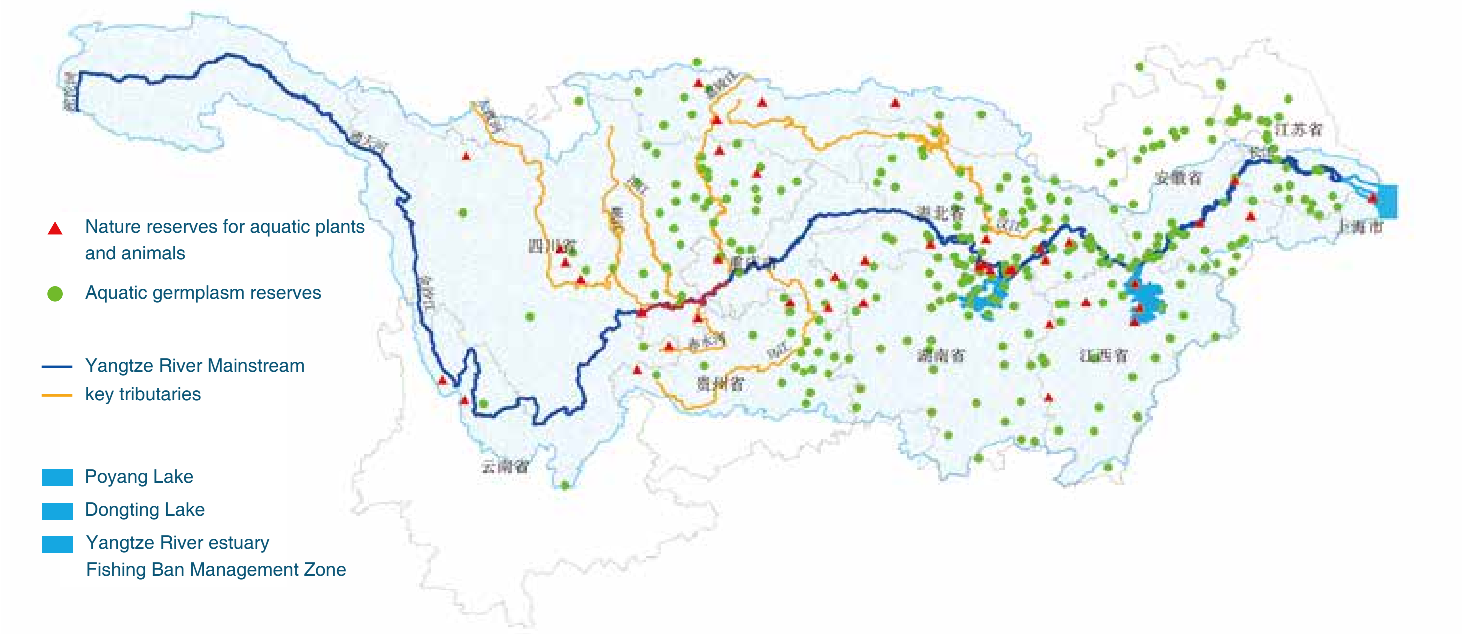

Chinese Sturgeon © Lei Jinyu / WWF


Drought at Honghu Lake © Wei Baoyu / WWF

4.3 Ten-year Fishing Ban: Dilemma, Policy, and Solutions

Ecological restoration and protection play a crucial role in preserving Yangtze River ecological systems. To restore the Yangtze aquatic environment, it is essential to identify key issues, including problems stemming from the construction of water conservancy projects, shore hardening, river blockage, and land reclamation.

The Ten-year Fishing Ban was implemented in 332 conservation areas throughout the Yangtze River Basin beginning January 1, 2020. The ban strictly prohibits fisheries activities (excluding aquaculture) in key areas, including the main channel of the Yangtze River, two major lakes (Poyang Lake and Dongting Lake), seven key tributaries, and the Yangtze River estuary. The Ten-year Fishing Ban is a holistic and long-term initiative designed to benefit future generations. It represents a significant move towards the conservation of the Yangtze River and the development of sustainable civilization reflecting sound ecological principles.



Aquatic plants and animals nature reserves	Yangtze River mainstem, the Yangtze River EstuaryFishing Ban Management Zone and key tributaries	Poyang Lake and Dongting Lake	Other key water areas
Since January 1, 2020, production fishing has been completely banned in 332 aquatic plants and animals nature reserves in the Yangtze River Basin.	Starting from January 1, 2021, a 10-year fishing ban in theYangtze River mainstem from below Qu Malai County to the river estuary, the Estuary Fishing Ban Manage-mentZone, as well as key tributaries including Daduhe River.Minjiang River, Tuojiang River, Chishui River, Jialing RiverWuiiang,River and Hanjiang River, has been implemented	Starting from January 1st, 2021, natural water areas including large Yangtze River-connected lakes such as Poyang Lake and Dongting Lake, except for aquatic plants and animals nature reserves and aquatic germplasm reserves, will have their fishing ban areas designated by relevant administrative depart-ments, and implement a 10 years fishing ban.	For other nature water areas connected to the mainstem of the Yangtze River, key tributaries, and large interconnected lakes, the provincial-level fisheries administrative authorities determine the scope and duration of fishing bans.

Fig. 4-6 2022 Comprehensive LYI of the Yangtze River mainstem and the "Four Lakes"

Column 5

The Implementation of the Yangtze River Ten-year Fishing Ban

The aquatic life in the Yangtze River is facing threats from various human activities, including overfishing, hydroelectric development, shipping, sand mining, urbanization, and agriculture.

The populations of rare species continue to decline or become extirpated. Based on the latest Scientific Investigation results released by the Ministry of Agriculture and Rural Affairs in 2022, the population of the only remaining mammal in the Yangtze River, the Yangtze finless porpoise, is now estimated to be only 1249 individuals.

The Baiji dolphin *(Lipotes vexillifer)*, also known as the "the giant panda of the water," is an endemic freshwater whale species found only in the middle and lower reaches of the Yangtze River. In 2007, the Baiji dolphin was declared functionally extinct, meaning their numbers are so low that they are unable to sustain a viable population or carry out essential ecological functions.

The Yangtze sturgeon *(Acipenser dabryanus)*, also known as the Dabry's sturgeon, is a rare and unique wild animal found exclusively in the upper reaches of the Yangtze River. The evolutionary origins of the Yangtze sturgeon can be traced back to approximately 150 million years ago. Since the early 20th century, reproduction of the Yangtze sturgeon in the wild has ceased, bringing it dangerously close to extinction.

The Chinese sturgeon *(Acipenser sinensis)* is distributed from the lower reaches of the Jinsha River to the estuary of the Yangtze River and exhibits migratory or semi-migratory behavior. It is classified as a National Class I protected animal in China. Since 2013, spawning of wild Chinese sturgeon has become extremely difficult to observe. In 2020, only 13 individuals were detected during the spawning period at the Gezhouba Dam.

Fisheries resources are on the verge of exhaustion. For example, Reeves' shad *(Tenualosa reevesii)* is now extinct, while the numbers of wild pufferfish *(Tetraodontidae)* and ribbon fish *(Coilia nasus)* have declined rapidly. The larvae of the four major Chinese carp have declined by over 90% compared to the 1950s, and the spawning stock has plummeted from a peak estimate of 120 billion to less than 1 billion. Furthermore, 79 fish species in the upper reaches of the Yangtze River are currently threatened, with the Chinese mitten crab *(Eriocheir sinensis)* on the brink of extiction.

The rapid and extensive economic development model of the past few decades has imposed severe environmental costs. Illegal fishing methods such as electric shock and blocking nets resulted in a vicious cycle of "decreasing resources, deteriorat-ing ecology, and impoverished fishermen". The integrity index of the biological resources in Yangtze River reached the lowest level of "no fish". The implementation of a fishing ban was urgently needed to allow the Yangtze River to recuperate.

Since 2003, a short term fishing ban lasting three to four months during spring has been implemented in the Yangtze River Basin. However, the effectiveness of the short term fishing ban was limited. When the fishing ban ended on July 1st, the breeding production of the year were quickly depleted due to resumed fishing. Fish populations thus did not increase nor did fishes species reproduce.

In January 2020, the Chinese Ministry of Agriculture and Rural Affairs released The Ten-year Fishing Ban Plan. It announced the implementation of a 10-year fishing ban in the key areas of the Yangtze River, starting from January 1, 2020. The plan prohibits commercial fishing of wild fishery resources within the main channel and key tributaries of the Yangtze River for a period of ten years.

Yangtze Finless Porpoise © Yang He


© Ma Mengqi / WWF

In 2021, the ten-year fishing ban on the Yangtze River commenced, resulting in the decommissioning of 111,000 fishing boats involving 231,000 fishermen. The implementation of the ten-year fishing ban, along with protective measures for aquatic life, has successfully curbed the sharp decline of the aquatic biological resources in the Yangtze River.

Our investigations reveal that fish resources have doubled, and the number of endemic larvae fish species increased from 32 to 37 in the Chishui River since 2017, when a comprehensive fishing ban pilot began. For example, Coilia nasus in Poyang Lake experienced a significant increase in 2020 and 2021, contributing to the cancelation of the special (licensed) fishing in 2018. In 2021, Coilia nasus were observed migrating to the Dongting Lake, while Ochetobius elongatus reappeared in the middle reaches of the Yangtze River.

Ecological restoration and protection is important for restoring the environment of the Yangtze River. The initial step in this process is identifying the issues affecting its aquatic biota. The implementation of the ten-year fishing ban on the Yangtze River is a critical measure to address the crisis of overfishing. However, the fragmentation or shrinkage of habitats caused by multiple human activities such as shoreline development, shipping, urbanization, and sand mining are other important factors threatening fish resources (and thus biodiversity) of the middle and lower reaches of the Yangtze River.

To further enhance the function of aquatic biodiversity and aquatic ecosystem and stability of the Yangtze River, we suggest：

1.Shoreline Restoration and Protection

The natural shoreline serves as an important indicator of the health of aquatic biota of the Yangtze River. Building on previous shoreline restoration efforts, further endeavors will be undertaken to strengthen restoration and protection：

• Classifying Shorelines for Protection. Based on natural state and development levels of the shoreline, the shoreline can be classified into three categories with proposed management requirements for each: strict protection, restricted development, and optimized use. The shoreline under strict protection should be designated in accordance with the requirements of an ecological protection 'red line.' Non-essential hardened shorelines should be dismantled and habitats should be restored for aquatic organisms.

• Scientific planning and ecological embankment construction. Ecological embankments are artificial embankments designed to mimic the attributes and functions of a natural shoreline. They integrate plants with civil engineering techniques to facilitate water and soil infiltration and enhance the lateral connectivity of water. This is a new type of embankment that combines effective flood control, ecological benefits, aesthetic appeal, and self-purification capabilities.

• Enhancing dynamic monitoring of the shoreline. The monitoring of shorelines is a key aspect of ecological protection monitoring. Remote sensing techniques can be used to monitor shoreline resources, evaluate development and human activities, and reinforce the protection and management of the shoreline.

2.Floodplain Restoration and Protection

The floodplain refers to the low-laying area of a river valley that becomes submerged during floods and is formed through the river's migration and the deposition of flood sediments. It is characterized by lush wetland and aquatic vegetation, serving as crucial spawning grounds and nururies for fish, porpoises, and waterbirds. The floodplain plays an important role in purifying water quality, stabilizing riverbanks, and beautifying the environment. At one point, the total area of floodplains in the middle and lower reaches of the Yangtze River was 7,000-9,000 square kilometers. However, the accelerated decline of natural floodplains has led to the loss of biodiversity and a crisis of ecological security for aquatic biota in the Yangtze River.

Restoration and Protection Measures Include:

• In areas that are suitable for natural restoration, the dismantling of artificial embankments should be followed by natural restoration methods. For shorelines and shoals that have been used or recently dismantled, adaptive restoration methods should be employed, taking into account the characteristics of different river sections. This can include promoting ecological navigation channels and environmentally friendly shipping methods for deep-water navigation channels, reducing ship pollution and noise, and creating more space for the migration of large species such as Yangtze finless porpoises and Chinese sturgeon. For shoals, restoring natural river floodplain substrate dominated by gravel is recommended.

• Establishing multi-functional vegetation belts on river floodplains. Reflecting the unique characteristics of different river sections, vegetation belts should be constructed to restore the natural function of river floodplains as habitats for the growth and development of aquatic organisms.

3.Navigation Channels Restoration and Ecological Protection of Secondary Watercourse

Restoration of Navigation Channels and Ecological Protection of Secondary Waterways

The Waterway Regulation Project has resulted in alternations to the underwater ecological environment, and in some cases, complete destruction of local environments, leading to substantial impacts on the populations and diversity of phytoplankton, macroinvertebrates, and fish. Secondary waterways serve as critical habitats for aquatic species in the Yangtze River.

Restoration Measures：

• Strengthen monitoring. Evaluation of ecological impacts should be conducted before and after each project, followed by ecological restoration. Prior to construction, careful consideration should be given to the timing, with a preference for the low water period when breeding activities are few. During construction, efforts should be made to minimize disturbance of the water column and suspended solids should be controled. Strengthened monitoring and management are necessary throughout the construction phase, including ecological, hydraulic, siltation monitoring and overall stability monitoring. After completion of any navigation channel improvement project, the effectiveness of the monitoring should be evaluated. Furthermore, ecological restoration should be undertaken, with a focus on the restoration of secondary water courses.

• Ecological navigation channels construction. Ecological navigation channels aim to integrate the navigation function of traditional navigation channels wehile maintaining key aspects of river ecosystems. They involve the implementation of novel ecological engineering methods during the construction and improvement of navigation channels. These methods take into account the attributes of aquatic ecosystems, aquatic biota present, and nature of the local environment.

4.Noise Pollution Control

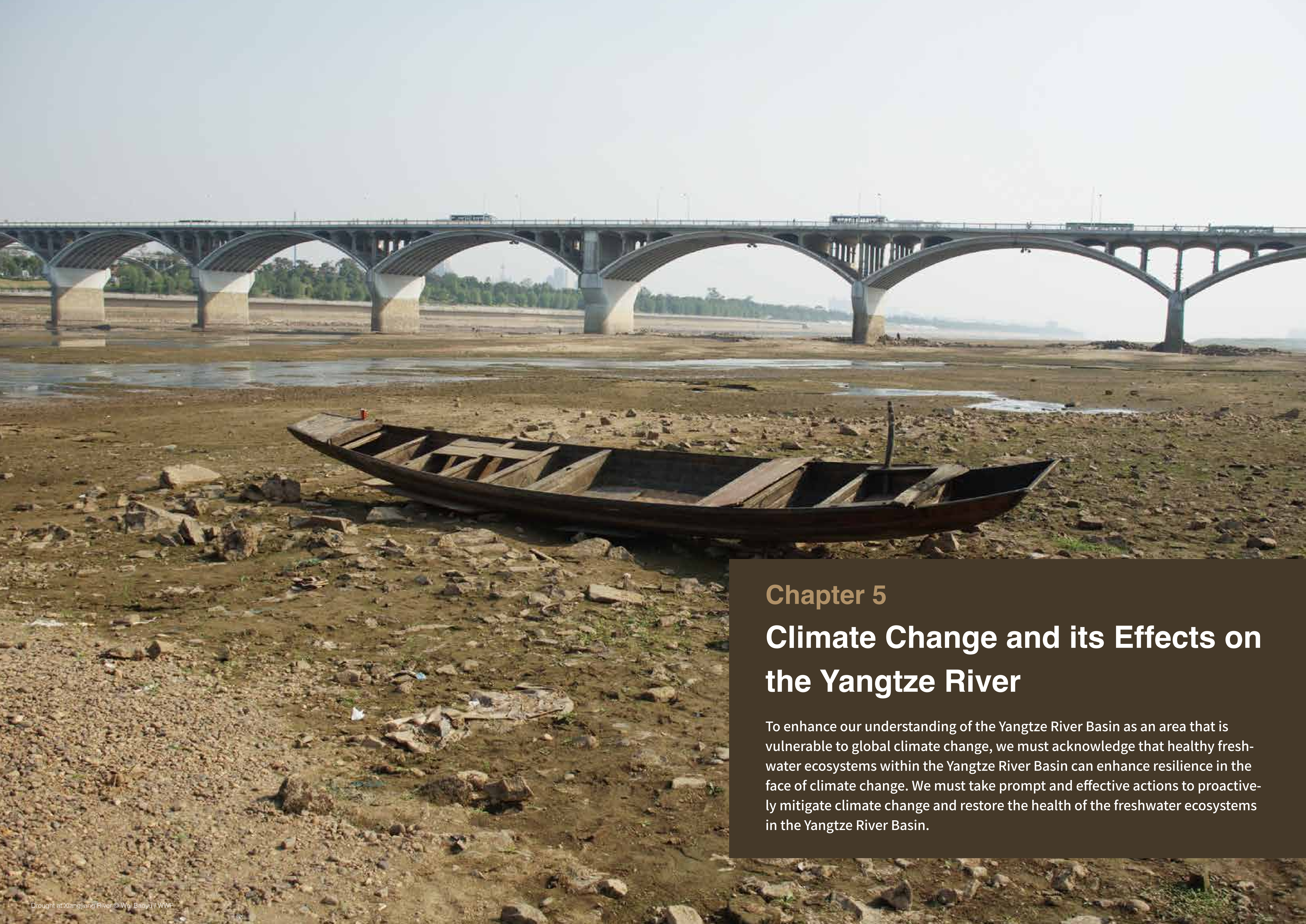
Shipping in the Yangtze River contributes to underwater noise. Underwater noise generated by ships can be categorized into several types, including hydrodynamic noise, flow-induced noise, propeller noise, and structural noise. These noise sources in the Yangtze River have significantly affected the well-being of aquatic species such as Yangtze finless porpoises and fish comprosmising communication, demographics, and breeding.

Control Measures Include:

• Scientific navigation. It is important to minimize unneccesary navigation of ships by reducing ship traffic in areas that overlap breeding grounds.

• Using new composite materials. New composite materials and augmented use of sound-absorbing equipment should be included in ship design and construction.

We believe that the ten-year fishing ban marks not the culmination of comprehensive biodiversity conservation efforts in the Yangtze River, but rather their inception. We must acknowledge the importance of the fishing ban for safeguarding aquatic biodiversity, but also the collective impact of multiple, diverse conservation strategies in addition to the fishing ban policy as "multiple driving forces" for the protection of aquatic organisms.



Drought at Xiangjiang River © Wei Baoyu / WWF

Chapter 5

Climate Change and its Effects on the Yangtze River

To enhance our understanding of the Yangtze River Basin as an area that is vulnerable to global climate change, we must acknowledge that healthy freshwater ecosystems within the Yangtze River Basin can enhance resilience in the face of climate change. We must take prompt and effective actions to proactively mitigate climate change and restore the health of the freshwater ecosystems in the Yangtze River Basin.

Worldwide, the United Nations has identified climate change, environmental pollution, and biodiversity loss as three major global environmental crises.

Climate change, biodiversity loss, and extreme weather events present significant challenges to humanity, creating urgency and importance of global ecological and environmental governance to unprecedented levels. Moreover, the ongoing COVID-19 pandemic introduced new challenges to existing crises faced by human society. The establishment of the United Nations Sustainable Development Goals (SDGs) indicator system highlights the interconnectedness of the economics, social well-being, and the environment, emphasizing the need for synergistic progress across all development goals. The 2030 Sustainable Development Goals, encompassing the three pillars of economy, environment, and society, impose more requirements for ensuring environmental security.

In 2022, the 15th Conference of the Parties to the Convention on Biological Diversity (COP15) (Part Two) and the 27th Conference of the Parties to the Convention on Climate Change (COP27) were held in Montreal and Sharm El Sheikh respectively. These conferences made significant progress in advancing the Post-2020 Global Biodiversity Framework with comprehensive agendas of addressing climate change through "mitigation, adaptation, and disaster risk reduction actions". Strengthening the synergies between biodiversity conservation and climate change mitigation and adaptation has become a central focus in global ecological and environmental governance.

As a crucial component of Earth's systems, freshwater ecosystems are extremely vulnerable to changes both natural and those caused by human factors. Climate change poses a severe threat to various freshwater ecosystems though increased water temperature, shifts in precipitation patterns and water flow conditions, non-native species invasions, as well as the rise in frequency of extreme events.

The freshwater ecosystems of the Yangtze River play a critical role in ensuring food security, human health, drinking water supply, energy production, industrial development, economic growth, and contributing to the overall health of the ecosystems, aquatic, transitional, and terrestrial. During the drought crisis of 2022, water scarcity and the need for efficient water resource allocation came into sharp focus, as the public experienced the profound impact of extreme weather events.

It is crucial to increase the awareness about the sensitivity of the Yangtze River Basin to global climate change. Recognizing that healthy freshwater ecosystems in the Yangtze River possess greater adaptive capacity to confront climate change is essential. Therefore, we must take effective actions to mitigate climate change and restore the health of Yangtze River freshwater ecosystems.

5.1 Climate Change and the Hydrological Processes of the Yangtze River

Climate change has presented a range of challenges in the Yangtze River Basin. The region has experienced an increase in the intensity and frequency of extreme hydrological disasters, including floods and droughts. In addition, there has appeared a new climatic regime characterized by a warm and wet conditions that may persist.

Global warming has led to alterations in the hydrological cycle, resulting in changes to the natural hydrological regime and spatio-temporal distribution patterns of water resources.

The Yangtze River Basin is located in the subtropics, dominated by the East Asian Summer Monsoon. It extends from high terrain in the northwest through to low terrain in the southeast, forming a narrow strip that opens to the southeast and faces the Pacific Ocean. The Basin experiences significant front activity, frequent cyclones, and a diverse range of precipitation types. Climate change has contributed to a distinct pattern of short duration, high intensity of precipitation in the Yangtze River Basin. Research indicates that under a global warming scenario of 1.5°C, there is a clear upward trend in the extreme precipitation events, increasing the risk of intense and frequent rainfall in the Yangtze River Basin. Particularly, the Sichuan Basin and the middle and lower reaches of the Yangtze River will be more susceptible to high-risk flood disasters. Research has demonstrated significant impacts of El Niño events in the Yangtze River Basin reflected in two types of El Niño indices, with the Yangtze River main channel, the Three Gorges Plain, Dongting Lake, and the Poyang Lake Basin exhibiting stronger correlations with these El Niño events relative to other sub-basins.

The Increase of the Intensity and Frequency of Extreme Hydrological Events

With global climate change, many rivers around the world are experiencing more frequent extreme weather events. Among the climate factors affecting runoff, the elastic coefficients of runoff change in the following order: precipitation > land use/land cover change (LUCC) > relative humidity > solar radiation > maximum temperature > wind speed > minimum temperature. Research indicates that climate change accounts for 78.7% of the net flow change in the Yangtze River Basin. Between 2001 and 2014, climate change resulted in a decrease of approximately 11.6 mm of runoff in the Yangtze River Basin's runoff. Under the RCP4.5 emmisions scenario, although the average runoff at Cuntan station in the upper Yangtze River Basin is projected to increase slightly from 2011 to 2040, it shows a gradual decline trend overall. The peak flow in the Yangtze River Basin may increase, and the occurrence of extreme floods in the basin may become more frequent in the future. Vegetation plays a direct role in the process. The current land use in the Yangtze River Basin has led to a decrease in surface runoff, resulting in a reduction of available water resources and water scarcity issues.

The source of the Yangtze River is expected to continue exhibiting a warm-wet climatic pattern. Based on data gathered from the six meteorological stations around the source of the Yangtze River, including TuoTuo River, WudaoLiang, Qumalai, Zaduo, Qingshui River, and Yushu (see details at http://data.cma.cn/), temperature and precipitation in the source of the Yangtze River have increased from 1956 to 2018, at estimated rates of 0.36°C/10a and 7.8mm/10a. The temperature and precipitation increases became more pronounced after 2000. The multi-year average temperature and precipitation from 2001 to 2018 were -1.0°C and 428.7mm, respectively, an increase of 1.4°C and 11.5%, compared with the multi-year average from 1956 to 2000 (see Figure 5-1 and 5-2 for details). These findings indicate that the Yangtze River source region has shown a warm-wet climatic pattern in the past 20 years. Furthermore, both precipitation and temperature are projected to continue increasing in the coming 20 years.

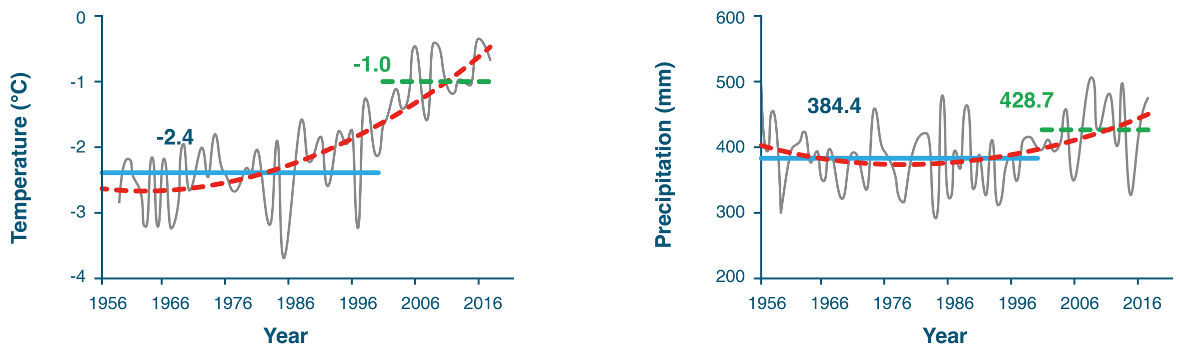


Fig. 5-1 2022 Comprehensive LYI of the Yangtze River mainstem and the "Four Lakes"

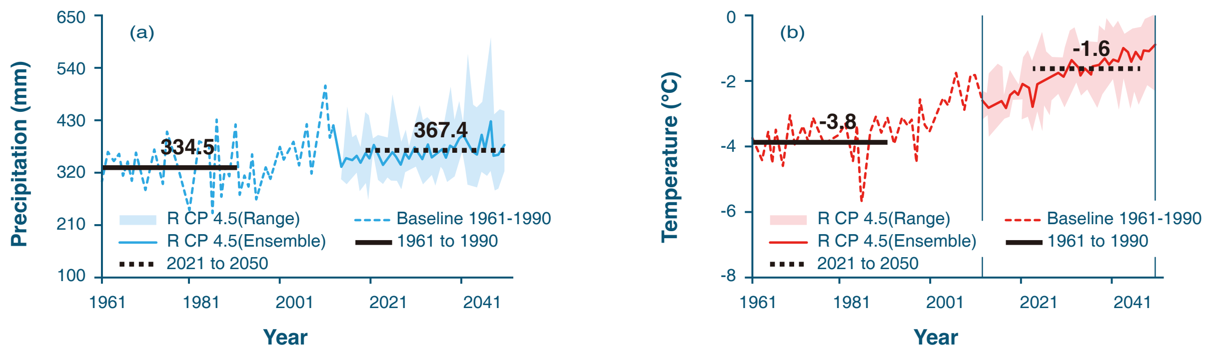


Fig. 5-2 2022 Comprehensive LYI of the Yangtze River mainstem and the "Four Lakes"

5.2 Climate Change Imposes Pressure on the Water Environment of the Yangtze River

The Yangtze River Basin is vulnerable to global climate change due to its unique geographical location.

The Yangtze River Basin is situated at the intersection of warm and humid oceanic climate and continental climate, making it highly vulnerable to the influence of subtropical high pressure systems and changes brought about at this climatic interface. The river basin is therefore a highly sensitive area to the impacts of global climate change. The interface between the two climate zones significantly impacts the temperature and precipitation pattern within the Yangtze River Basin. Rising temperature has led to increased evaporation rate, especially in lakes and reservoirs, which in turn contribute to the concentration of pollutants in water bodies. This exacerbates groundwater and surface water pollution, accelerates eutrophication, and alters water quality. The functioning and processes of aquatic ecosystems are therefore adversely affected.

5.3 Climate Change Affect the Pattern of the Yangtze River Aquatic Ecosystem

To propose effective measures allowing aquatic organisms to respond climate change, we must adopt a progressive approach. It should prioritize the preservation of aquatic biodiversity while ensuring its resilience to changing climate conditions.

Biodiversity conservation and climate change governance have emerged as crucial elements of sustainable development strategies for humanity, garnering attention both domestically and internationally. Within the context of Yangtze River freshwater ecosystems, it is imperative to coordinate actions for conservation of aquatic biodiversity and climate change. Climate change can significantly impact freshwater aquatic organisms, compromising their persistence. Furthermore, climate change and ongoing human activities have resulted in a more pronounced decline in freshwater ecosystems compared to terrestrial and marine ecosystems.

Aquatic biodiversity is significantly affected by temperature changes, and thus climate change poses a challenge to species adaptability. Factors such as water temperature, water flow, and photoperiod have a notable impacts on fish reproduction. The rise in temperature resulting from climate change can disrupt freshwater and nearshore biomes. Safeguarding aquatic biodiversity and preserving the interconnectedness of freshwater ecosystems also hold immense significance their functioning as dynamic carbon sink resources. The Yangtze River Basin has encountered nearly 30 invasive fish species. Alterations in natural distribution patterns caused by climate change can contribute to such biological invasions and exacerbate such problems.

Climate change has a profound impact on the primary productivity of aquatic ecosystems. The rivers and lakes within the Yangtze River Basin play a crucial role in regional climate regulation, with aquatic organisms actively participating in the carbon cycle. Aquatic vegetation absorbs, stores carbon, and mitigate the release of carbon in sediments. This process involves smaller organsims like plankton and macroinvertebrates. Preserving carnivorous populations in rivers, for instance, can help conserve macroinvertebrates organisms.

A future characterized by warmer and more extreme climate conditions may have adverse effects on many freshwater organisms within the Yangtze River Basin. We must adopt a forward-thinking approach when creating climate change measures to help to conserve aquatic organisms. These measures should aim to mitigate impacts of climate change while minimizing repercussions on aquatic biodiversity. Moreover, they should include scope for adaptation of aquatic organism to changing climate conditions.

5.4 Climate Change Affects Water Resources and Responding Adaptation Strategies

Global climate change has accelerated global hydrological circulation processes, resulting in a higher occurrence and intensity of extreme weather events like heavy rains, storm surges, widespread droughts, and floods. Moreover, rising global temperatures result in increased water consumption demands, aggravating the disparity between water resource supply and demand.

To address the impact of climate change on water resources in the Yangtze River Basin, we must implement adaptive measures based on the principle of sustainable development to protect and manage water resources.

We propose the following:

• It is important to: 1. enhance climate change monitoring, prediction, and data collation platforms. 2. establish comprehensive research systems that encompass assessment of impacts, vulnerability, risk, and capacity for climate change adaptation. 3. strengthen the effectiveness of adaptive measures.

• To enhance emergency response capacities for flood and drought across the basin, we must strengthen monitoring and early warning capabilities, improve the accuracy of rainfall, flood and drought forecasting, implement comprehensive treatment of important river sections in key small and medium-sized rivers, and complete the reinforcement of small reservoirs while constructing warning and forecasting systems for areas prone for flash floods.

• To establish a water-economy society and achieve efficient use of water resources, we must promote comprehensive water-saving measures encompassing technology, economy, and administrative policies. Additionally, we must accelerate the construction of water infrastructure such as reservoirs, ecological river embankments, and retention basins, and should implement the "Five Small Water Control Projects" that will enhance the spatiotemporal allocation capacity of water resources.

• To enhance sewage treatment, and seawater and rainwater harvesting , we must address technological bottlenecks, reduce the cost of consuming unconventional water resources, adjust the industrial structure, promote energy conservation, improve energy efficiency, develop new, affordable, and renewable energy sources, decrease carbon dioxide emissions, and mitigate climate change.

Column 6

The 2020 Flood in the Yangtze River Basin

During June and July 2020, the Western Pacific subtropical high exhibited increased in size and intensity. The southwest airflow brought copious amounts of water from the Bay of Bengal or South China Sea to the southern part of China. Simultaneously, active cold air in the north contributed to frequent and continuous heavy rainfall. As a result, the Yangtze River Basin experienced exceptionally high levels of rainfall during the flood season, culminating in severe flooding across the region.

It exhibited the following characteristics:
Upstream water arrived early in the Yangtze system, and floods occurred over a wide range of space. The flood peaks in the upstream parts of the river were high and the volume was large. In June of that year, there were significant excesses of water in the upper reaches of the Jinsha River, Yalong River, and Dadu River in the northwest region of the upper reaches of the Yangtze River. The Dadu River, as well as the southern tributaries of the upper Yangtze River including the Hengjiang, Qijiang, and Wujiang, experienced floods that exceeded warning levels and even surpassed the regular water level. The Three Gorges Dam experienced two inflow rise events of approximately 35,000 m3/s, the earliest since its construction. From June to August, among the 17 rivers that are the main sources of flooding in the Yangtze River, all except the Xiangjiang and Hanjiang rivers, experienced floods exceeding the warning levels. The main channel of the Yangtze River experienced five floods, and there was a major flood in the upper reaches of the Yangtze River. The Poyang Lake basin experienced unprecedented major floods, and the entire section of the river below Shashi exceed the warning level.

Prominent floods occurred in the main channel of the Yangtze River. Due to heavy rainfall, several key waterbodies in the middle and lower reaches, including Changhu Lake and Hong Lake in Hubei, Poyang Lake in Jiangxi, and Chaohu Lake and the Chuhu River in Anhui, witnessed floods surpassing historical levels. Dongting Lake in Hunan also encountered floods exceeding the warning water level. Floodwaters were managed by storing them in dikes and embankments in Jiangxi and Anhui.

The water level of the main channel in the middle and lower reaches experienced a rapid rise, characterized by high flood peaks and sustained high water levels. In June, the water level at the control stations of the main channel and the two lakes in the middle and lower reaches increased rapidly. This trend intensified notably in July, with a substantial surge in water level. The combination of increased water inflow from upstream and the accumulation of flood waters downstream led to a swift surpassing of the warning level and a nearing of the warning water level in the main channel of the middle and lower reaches.

The coordinated operation of reservoirs had a significant influence. Between July and August, the combined storage capacity of the reservoirs included in the joint operation of the Yangtze River basin increased by about 26.7 billion cubic meters Taking into account the flood control capacity of each reservoir, the reservoirs collectively intercepted and stored around 50 billion cubic meters of floodwater. The extensive joint operation of reservoirs in the upper and middle reaches brought about significant alterations to the hydrological processes within the downstream reservoirs.

In June and July 2020, the mid- to high-latitude atmospheric circulation in Eurasia displayed a distinct "two troughs and two ridges" pattern, while the subtropical high in the western Pacific exhibited an unusually strong intensity compared to normal years. Further, the persistent abnormal sea surface temperatures from the previous period further contributed to these conditions. As a consequence, the Yangtze River Basin experienced exceptionally high levels of precipitation, characterized by multiple prolonged heavy rain events over an extensive area. This combination of factors drove the widespread flooding observed in the basin.

The impacts of flooding in 2020 on the intricate ecological systems of the Yangtze River Basin were far reaching. According to data provided by the Ministry of Emergency Management, starting from June 1, 2020, when the primary flood season commenced, until August 2, when the rainy season concluded, the floods in the southern regions affected a total of 54.81 million people, resulting in 158 deaths, with a direct economic loss of 144.4 billion yuan.

The occurrence of extreme heavy rainfall can have repercussions on water quality and the aquatic environment, potentially exacerbating water pollution. In the Yangtze River Basin, pollution is primarily attributed to the discharge of industrial and domestic wastewater from cities along the river, as well as agricultural wastewater. It is important to note that the pollution in the Yangtze River Basin is not directly caused by the river's own water resources.

The impact of the extreme flooding on people's lives and livelihood is evident in various ways, including on their health and food security. For example, the floods have significant local impacts on food production, especially in the agricultural regions of the middle and lower reaches of the Yangtze River and the Huaihe River basin.

Column 7

2022 Yangtze River Basin Drought and Heatwave

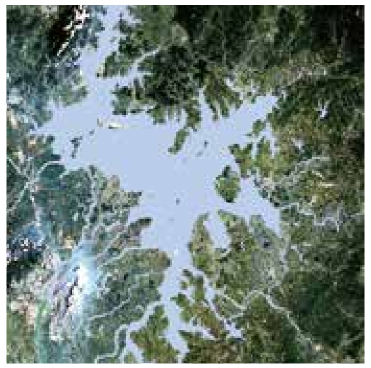
Against a background of climate change, since July 2022, the Western Pacific subtropical high has been larger and stronger, and the duration longer, with a position biased to the west and north. It also lingered over the Yangtze River Basin for a prolonged duration. Controlled by the subsidence airflow of the subtropical high, cold air directly southward of the sea cannot affect the lower reaches of the Yangtze River, resulting in continuous high temperature and less rain in the entire basin. The inflow of the main rivers and lakes in the basin were significantly less, and the water levels were significantly lower. This led to a rare drought situation compared to the same period in many previous years. Typically, June is the rainy season in the middle and lower reaches of the Yangtze River Basin. However, precipitation in the basin has gone from being excessive to insufficient, leading to the abnormal phenomenon that the flood season marking an opposite disaster: drought.

During the flood season, the Yangtze River and its tributaries received 20-80% less water than usual, reaching the lowest levels in the upper and middle reaches since 1949. The Three Gorges Reservoir and Danjiangkou Reservoir on the Han River experienced a decrease of more than 40% and nearly 70% in water inflow, respectively. As a result, the water levels of the Yangtze River mainstem, Dongting Lake, and Poyang Lake dropped by 4.85-6.13 meters below their typical levels. Further, the surface area of Dongting Lake and Poyang Lake shrank by three-quarters compared to June. By August 6, the water level at the Xingzi Station of Poyang Lake had fallen to 11.99 meters, making the commencement of the dry season 100 days earlier than hydrological records indicate since 1951. On August 15, the water levels at the main control stations of the Yangtze River were observed as follows: 17.30 meters at Hankou, 6.84 meters at Datong, 23.55 meters at Qilishan, and 10.37 meters at Hukou. These measurements represent the lowest levels recorded in history for the same period, with deviations of 6.08 meters, 4.96 meters, 5.87 meters, and 6.37 meters, respectively. The water level at the Qilishan station, located at the outlet of Dongting Lake, dropped to 24.50 meters lower than usual. In September, the water levels of the Yangtze River mainstem and the two lakes continued to decline, surpassing the historical record for the lowest levels over this same period historically.

The high temperature and drought have complex impacts on the ecosystems, economic outputs, and daily life in the basin. They affect various facets of human lives, including agricultural and urban water supply, causing a severe shortage of hydropower due to limited water resources, especially in Sichuan Province. Moreover, the high temperature led to a significant rise in electricity consumption among residents, exacerbating the energy supply-demand imbalance. Additionally, the high temperature contributes to an increase in the proportion of moderately eutrophic lakes and reservoirs. The combination of high temperature and low water levels led to higher concentrations of indicators related to shallow-water lakes including an amplified release of internal phosphorus and intensified exchange between the upper and lower layers of the lake. Consequently, there was an increase in the total phosphorus concentration in the lake.

June 2016 Dongting Lake Water Area Range

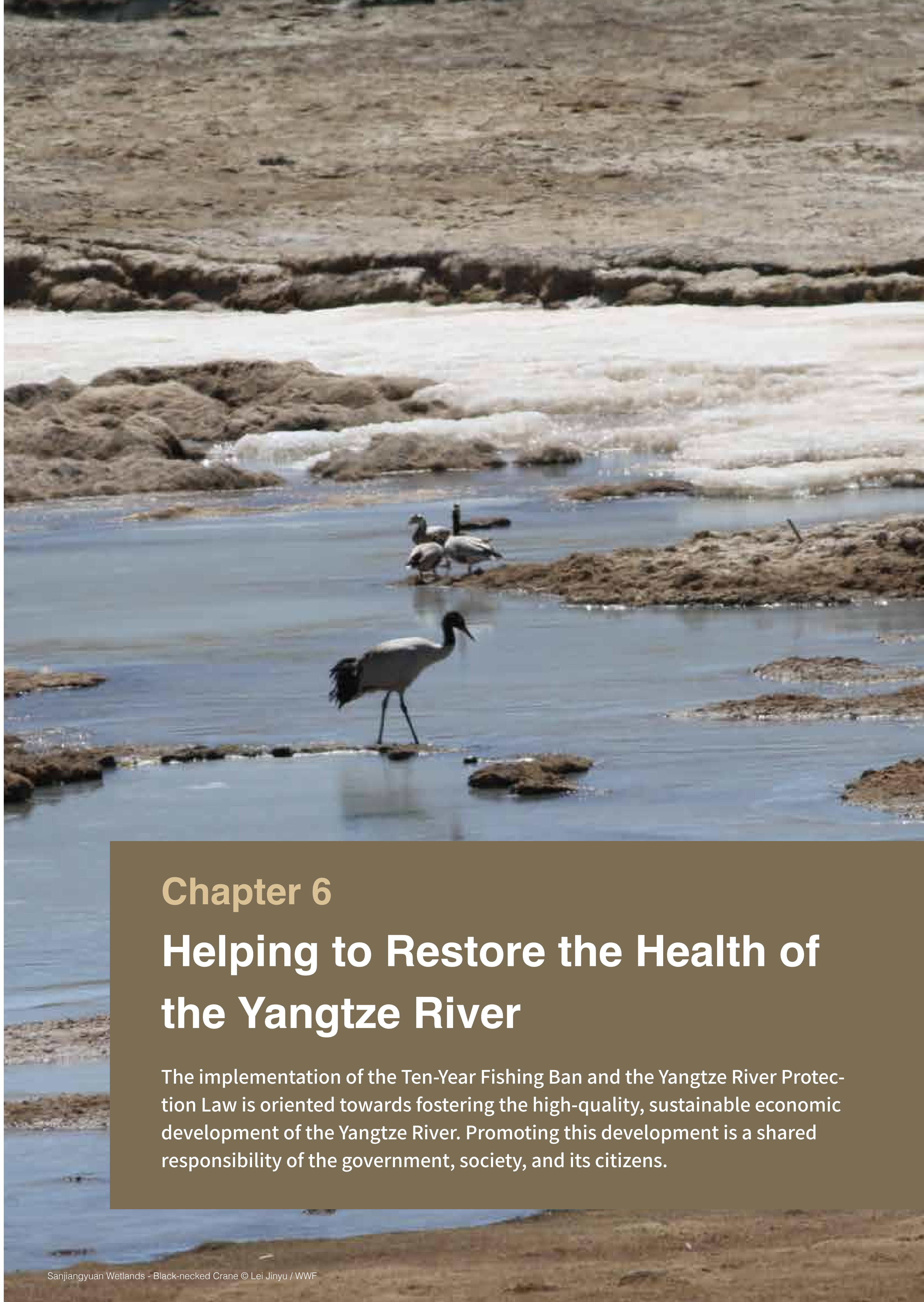
August 2022 Dongting Lake Water Area Range



June 2016 Pouang Lake Water Area Range

August 2022 Poyang Lake Water Area Range

Comparisons of the water area ranges of Dongting Lake and Poyang Lake across different time periods



Chapter 6

Helping to Restore the Health of the Yangtze River

The implementation of the Ten-Year Fishing Ban and the Yangtze River Protection Law is oriented towards fostering the high-quality, sustainable economic development of the Yangtze River. Promoting this development is a shared responsibility of the government, society, and its citizens.

Sanjiangyuan Wetlands - Black-necked Crane © Lei Jinyu / WWF

6.1 Policy Outlook

We suggest the following measures: identifying the minimum threshold for the protection of aquatic organisms, implementing projects for the protection and restoration, and utilizing the "fishery ban and fish returning" policy to establish an effective and transparent model for fishery development and management, incorporate well-defined property rights and sound institutional mechanisms.

The Yangtze River Protection Law

According to a survey conducted by the Environmental Planning Institute of the Ministry of Ecology and Environment on the Yangtze River Protection Law, the public widely acknowledges the importance of formulating and implementing this law. More than 90% of the respondents are familiar with the law through various means, and over 80% believe that it will bring positive changes to their environment. More than 90% of the public express their willingness to actively participate in the efforts to protect the Yangtze River.

However, during the implementation of the Yangtze River Protection Law, there are still problems such as incomplete supporting regulations, policies, and inadequate enforcement. Therefore, we recommend that the country, various departments, and local authorities continuously strive to improve their commitment to the law, fully implement the requirements of the Yangtze River Protection Law, and enhance the effectiveness of legal enforcement. First, it is crucial to establish and enhance the coordination mechanism for the Yangtze River Basin promptly. This includes continuously improving supporting policies related to biodiversity protection, fisher resettlement, river and lake shoreline management, and river sand mining. Second, the top-level design of Yangtze River protection and restoration needs to be strengthened. This involves expediting the the formulation and implementation of national land space planning, provincial-level plans for total phosphorus pollution control, and methods for water evaluation in the Yangtze River Basin. Third, the scope of related concepts such as "Yangtze River tributaries," "key lakes," "three kilometers," and "one kilometer" should be clarified through measures such as judicial interpretations. Fourth, the modernization of river basin protection capabilities should be prioritized, including implementation of Yangtze River Basin ecological census. Fifth, comprehensive law enforcement oversight in the river basin needs to be strengthened. Last, all parties must become more aware of their responsibilities, and strengthen legal awareness and literacy of society as a whole.

Supporting Policies for the Ten-year Fishing Ban in the Yangtze River

To improve the ecosystem of the Yangtze River, it is essential that we enhance policy for Yangtze River protection and restoration. This includes systematic restoration of biodiversity in the river basin and restoring connectivity among rivers and lakes. Additionally, restoring migratory pathways necessary for aquatic habitats, including foraging and spawning grounds, plays a crucial role in ensuring the vitality of Yangtze River Basin ecosystems.

Therefore, we suggest the following measures: first, we must transition from extensive to refined management and establish clear guidelines for the protection of aquatic organisms. Given the significant increase in the number of aquatic organisms in the Yangtze River Basin and the elevated level of protection and requirements, it is crucial that we comprehensively map the distribution of natural populations of aquatic organisms in the area. This includes conducting systematic investigations of key habitats such as spawning grounds, feeding grounds, overwintering grounds, and migration pathways of aquatic organisms. Additionally, improving the Yangtze River aquatic organism monitoring system is vital. Second, we should shift from point-based to systematic management and implement projects for the protection and restoration of aquatic organisms. This involves prioritizing rescue action plans and strengthening the protection and restoration efforts for rare and endangered species and their respective habitats. Specific actions should be taken for species such as the Chinese sturgeon, Yangtze finless porpoise, and Yangtze sturgeon. It is important to establish long-term protection mechanisms and enhance the capacity for species recovery and population restoration.

New patterns of industrial transformation and development, along with reforms for property rights for the sustainable use of Yangtze River aquatic resources, and modernization of fisheries governance and governance capacity are crucial steps. While the ten-year fishing ban has solved the issue of over-fishing among numerous fishermen, it is not a complete solution. With local fisheries recovering rapidly, it remains necessary to promote the transformation and upgrading of fisheries industry in key areas. This include exploring reforms to the property rights for fisheries resources in key water areas of the Yangtze River Basin and promoting the development of large-scale ecologically-based fisheries.

In conclusion, we make the following recommendations: First, it is crucial that we establish a new model for the development and management of fisheries in the Yangtze River Basin. This model should have clear property rights, improved managment systems, and efficient mechanisms, which can be achieved by the fishing ban policy. By restoring lakes and reservoir resources, strengthening fishery legal enforcement and supervision, and implementing comprehensive supervision and organized development, we can help cultivate the environment to benefit production, and restructure protection management and use system for fishery resources. This will help us to realize of the vision of "Lucid Waters and Lush Mountains Are Invaluable Assets".

Second, as the number of key protected wild animal species in the Yangtze River Basin increases, the risk of accidental catch also rises. Therefore, it is necessary to enhance the management of limited fishing species with a focus on protecting key aquatic wild animals. This includes guiding fishing enthusiasts to improve their fishing tools and techniques to minimize incidental by-catch.

Third, while maintaining the overall fishing ban, careful and scientific development of large-scale ecological aquaculture can be pursued to increase fish populations. Pilot projects should be selected in areas which will have minimal impacts on aquatic organisms. The release of fish species, quantity, and proportion should be determined based on the "one water, one policy" principle. The method of recapture should be reasonably determined, and efforts should be made to establish an organized, non-competitive new type of fishery production. Further, promoting the modernization of the fishery governance system and governance capacity is essential.

6.2 Technology Support

Population dynamics of aquatic organisms serves as a crucial indicator for the effectiveness of the fishing ban implemented in the Yangtze River. Following the ban, it is essential that we monitor and evaluate changes in key areas of the Yangtze River basin and key habitats of aquatic organisms. Such monitoring and evaluation efforts can provide a scientific foundation for the comprehensive protection and systematic restoration of Yangtze River ecosystems. To facilitate this process, the development and implementation of an enhanced and standardized technical system for aquatic ecological monitoring will play an important role.

Challenges and New Technology of Aquatic Biodiversity Monitoring

• Monitoring the Invasive Species

Invasive species have emerged as one of the foremost global environmental concerns in the 21st century. When non-native species successfully established themselves, they can compete with native species and become dominant and disrupt native biodiversity and local ecosystems. Eradicating invasive species is often challenging and costly. However, by implementing proactive monitoring and taking early actions, the chances of successful eradication can be improved, while reducing control cost. In recent years, the application of environmental DNA (eDNA) technology has gained traction in invasive species monitoring. eDNA has been employed worldwide to monitor non-native species such as American bullfrogs, Atlantic salmon, Hemimysis anomala, and Moby fish.

• Monitoring Endangered and Rare Species

Endangered or rare species often exhibit low population densities, making their monitoring challenging using traditional morphological identification methods. Traditional techniques, such as trawl nets and electric fishing, can have detrimental impacts on the ecosystem. In contrast, environmental DNA (eDNA) technology can offers a solution by circumventing these issues and providing particular suitable for monitoring endangered and rare species. Presently, eDNA technology has been successfully applied in the monitoring of species including European cisco（Coregonus albula), hellbender (Cryptobranchus alleganiensis), king salmon（Oncorhynchus tshawytscha), and Australian Macquarie perch (Macquaria australasica).

• Monitoring Biodiversity

Traditional monitoring techniques often struggle to accurately detect elusive or juvenile life-stage species, highlighting the need for a technology that can swiftly and precisely monitor biodiversity. In recent years, eDNA metabarcoding tools have gained prominence in biodiversity research. By employing eDNA metabarcoding technology and hydroacoustic methods, the limitation of traditional biodiversity monitoring techniques can be overcome. The rapid and efficient nature of the technology makes it an ideal tool for comprehensive biodiversity monitoring.

• Estimating Biomass

Biomass is a crucial biological parameter, yet its accurate determination can pose challenges. Researchers have tried to use eDNA technology to provide rough estimates of the biomass of amphibians, fish, and other species in aquatic ecosystems. These studies found that various factors including water temperature, pH, and light can influence the release and breakdown of eDNA, consequently affecting biomass estimation indirectly. As a result, further comprehensive research is necessary to deepen out understanding of eDNA technology in the context of biomass estimation.


Bar-headed Goose © Lei Jinyu / WWF

专栏 8

Environmental DNA (eDNA) Technology and Its Application

Environmental DNA (eDNA) technology has emerged as a prominent method for biodiversity monitoring in recent years. This innovative approach involves the extraction and analysis of residual DNA fragments from environmental samples including water, soil, and sediment. By analyzing the samples, researchers can gain valuable insights in the presence, abundance, and other information of one or multiple species in the corresponding environment.

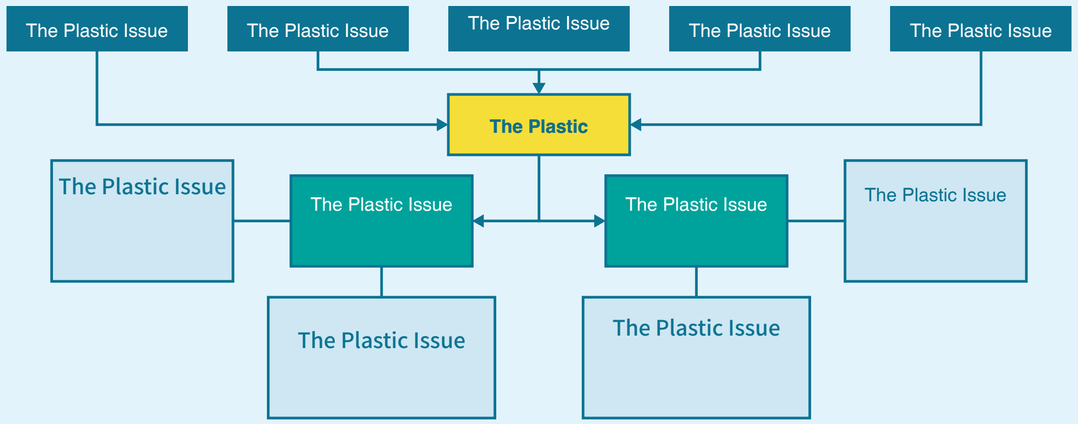
Within aquatic ecosystems, eDNA primarily originates from various sources such as surface tissues, excrement, and the decomposition of carcasses. The persistence of eDNA signals in water is affected by factors, including species' life history, behavior, physicochemical indicators, and hydrological conditions.

Compared to traditional methods of investigating biodiversity, eDNA technology presents three distinct advantages. Firstly, it is proved to be efficient and cost effective. Traditional approaches, including fishermen interview and trawling, demand substantial human and material resources. In contrast, eDNA technology help simplify the analysis process by capturing and filtering water samples, significantly reducing costs by 20%-60%. Secondly, eDNA technology exhibits exceptional sensitivity. Research has demonstrated that current eDNA detection techniques have achieved, or in some cases, exveeded the accuracy of traditional methods in identifying single or multiple species. It is particularly effective in monitoring rare or early-stage invasive species with low population densities. Thirdly, eDNA technology is non-invasive. Since the collection of eDNA samples does not involve direct contact or interaction with the target species, its application has minimal impacts on the environment and ecosystems.

In the past 5 years, the utilization of eDNA as a tool for exploring and monitoring species diversity has gained special popularity within the realms of ecology and conservation biology. It is now becoming a standard method for conducting biodiversity surveys in multiple countries, serving as both a reference and a valuable complement to conventional survey and sampling methods.

In recent years, substantial practical verification has promoted the extension of eDNA technology's application from single water bodies to broader geographical scales, including investigations at the basin level. Research conducted by Deiner et al. (2016) highlights that diversity information from upstream regions is transported through river networks, accumulating in downstream regions. Therefore, it becomes feasible to access the overall biodiversity of the entire basin by collecting eDNA samples at the confluence of tributaries.

Environmental DNA technology has been applied to monitor endangered species such as the Yangtze finless porpoise. Ma et al. (2016) were pioneers in developing the eDNA detection process for the porpoise. Tang et al. (2019) further demonstrated that eDNA technology outperformed traditional methods in monitoring the distribution of the porpoise in the field. These studies underscored the efficacy of eDNA technology. Given the fishing ban in the Yangtze River Basin, eDNA technology holds significant promise. Traditional fishing survey methods were constrained regarding identifying the diversity of fish. In contrast, eDNA technology presents the potential to enhance data collection by overcoming the limitations of conventional methods.



Sanjiangyuan Wetlands © Lei Jinyu / WWF

Acoustics Applications in Aquatic Organism Monitoring

• Estimating Aquatic Organismal Population Resources

Tools that use hydroacoustic frequency differences can be employed to identify and quantify target organisms by comparing responses to sound waves of varying frequencies. Primarily used in the study of fish and plankton, this technique has significant implications for evaluating specific aquatic resources. The frequency difference technique is commonly used for categorizing and assessing fish and plankton populations.

• Studying the Spatiotemporal Distribution of Aquatic Organisms

Acoustic data play a crucial role in studying the spatiotemporal distribution characteristics of many fish and other species. Acoustic technology can be effectively employed to monitor the breeding period of Chinese sturgeon and shifts in the spatiotemporal distribution of finless porpoises.

Application of spectral detection technology in ecological environment monitoring, warning, and tracing

Spectral monitoring technology encompasses various methods that use visible light, infrared, ultraviolet, and fluorescence technologies. When implemented on different platforms, such as remote sensing, drones, unmanned ships, spectral technology offers several advantages over traditional online monitoring techniques. These include fast response times, comprehensive spatial coverage, and the ability to gather extensive water quality information. In the realm of ecological assessment and monitoring, spectral monitoring can be harnessed for tasks such as identifying watershed habitat types, mapping species distributions, or monitoring and issuing alerts for water quality. By establishing a comprehensive monitoring system encompassing monitoring, warning, and tracing, spectral monitoring supports environmental surveilance and enforcement of environmental regulations.

• Coastal Aquatic Plant Species Distribution and Vegetation Mapping

Mapping species distributions and classifying and assessing types of habitats play a crucial role in studying the spatial distribution of vegetation and its adaptability to environmental shifts. For example, recent studies have used imaging data from unmanned aerial vehicle (UAV) to classify mangrove species. These studies provide valuable insights to support effective mangrove resource management and protection.

• Monitoring Coastal Habitat Types

Information on coastal habitat types can help us to evaluate the impact of human activities on aquatic organisms.

• Water Quality Warning

The use of hyperspectral sensors on remote sensing satellites, drones, and unmanned ships enables the acquisition of spectral data from water bodies. By analyzing the correlation between spectral data and relevant water quality indicators, it becomes possible to obtain a suite of water quality metrics for monitored water bodies, including estimates of organic matter, nutrients, and cyanobacteria. By integrating meteorological and solar radiation data, functionalities such as water quality and cyanobacteria bloom warnings can be obtained.

• Tracing Pollution Sources

To ensure effective law enforcement, we must develop rapid and accurate pollution tracing methods within the existing monitoring system. One promising approach to address this challenge is three-dimensional fluorescence spectroscopy, which provides comprehensive water quality information. Through the analysis of three-dimensional fluorescence spectral data, together with the sophisticated algorithms and comparison of pollutant sources unique spectral fingerprints, efficient and accurate traceability can be achieved.

6.3 Stakeholder Participation

The Yangtze River Basin stands out as an area where conflicts among national economic development, natural resource use, and biodiversity conservation are prominent. This region represents a complex system where nature, economy, and society are closely interconnected. The protection, management, and restoration of its rivers and lakes present technical, management, and institutional challenges.

WWF played a pivotal role in promoting the balanced development of the entire Yangtze River Basin, encompassing diverse ecosystems including montane, forests, fields, lakes, grasslands, as well as human-made elements such as roads, ports, banks, industries, and cities. The overarching objective is to revitalize the Yangtze River as the "river of life". Through two decades of dedicated efforts, WWF has fostered fruitful collaborations with administrative agencies and businesses operating with the basin, yielding remarkable achievements.

In close collaboration with the Ministry of Water Resources and related basin management institutions, WWF has been instrumental in the comprehensive management of the river basin from concept to action.

Through collaboration with the Office of Wetland Conservation and Management, WWF has played a crucial role in the establishment of the Yangtze Wetland Protection Network and continues to actively expand its influence within this platform. Presently, the network comprises 252 members, encompassing a vast area of 29 million hectares. This network serves as a robust ecological foundation for the sustainable economic development of the Yangtze River region.

In close collaboration with relevant departments of the Ministry of Agriculture and Rural Affairs, WWF has actively facilitated the interconnectivity of over 50 lakes in the middle and lower reaches of the Yangtze River. This has helped initiate the use of the technique of adopting fries. This initiative has been instrumental in revitalizing the lakes, while promoting sustainable livelihoods and business opportunities for the communities residing within the basin.

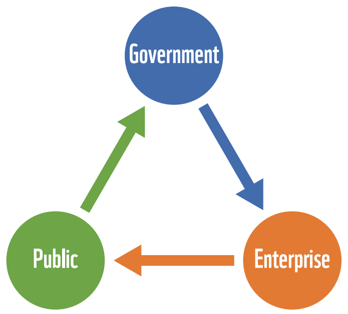


Figure 6-1 The "Government-Enterprise-Public" Triangle Model for Restoring the Yangtze River

In collaboration with the Three Gorges Corporation, WWF has been actively involved in promoting ecological operations aimed at meeting the flow requirements for major Chinese carp species in the lower reaches of the Yangtze River.

Dongting Lake © Zhang Yifei / WWF

Through partnership with universities and research institutes along the Yangtze River, WWF has initiated the Wetland Ambassador campaign. This campaign aims to inspire and engage university students in wetland conservation by encouraging them to actively explore and experience wetland environments.

On the occasion of the 7th anniversary of the Yangtze River conservation campaign, we strongly recommend that the government take leadership in promoting and encouraging active participation from businesses, research institutions, and social organizations. By fostering collaboration and collective action, we can embark on a new chapter that prioritizes ecological conservation and green development.

The active involvement of businesses and industry plays an indispensable role in the conservation of the Yangtze River. As businesses increasingly recognize the importance of environmental protection, they have transitioned from engaging in illegal discharge to complying with regulations. Moreover, they have taken on additional social responsibilities. Businesses now strive to integrate environmental and social responsibility into their own sustainable development strategies, enhancing their core competencies. The transformation from external pressure to internal motivation helps businesses to realize comprehensive green development.

For the future, as we strive to restore the vitality of the Yangtze River, we advocate for a tripartite model of "government-enterprise-public". This model encourages collaboration among various organizations for sustained contributions and for assuming shared responsibility in conserving the Yangtze River.

Column 9

Application of Science-Based Targets for Water in the Tai Lake Basin

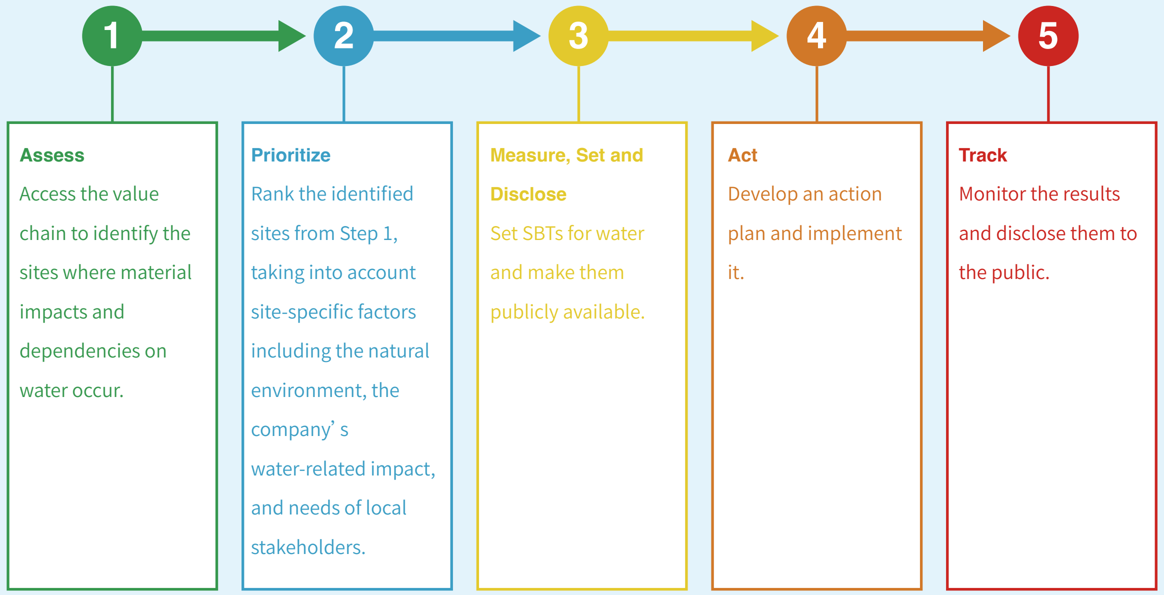
Water according to the United Nations is fundamental for achieving sustainable development. Human water consumption has increased sixfold in the last century growing at a rate of 1% per year. Water crises pose a significant challenge to humanity and the Earth's environment in the 21st century.

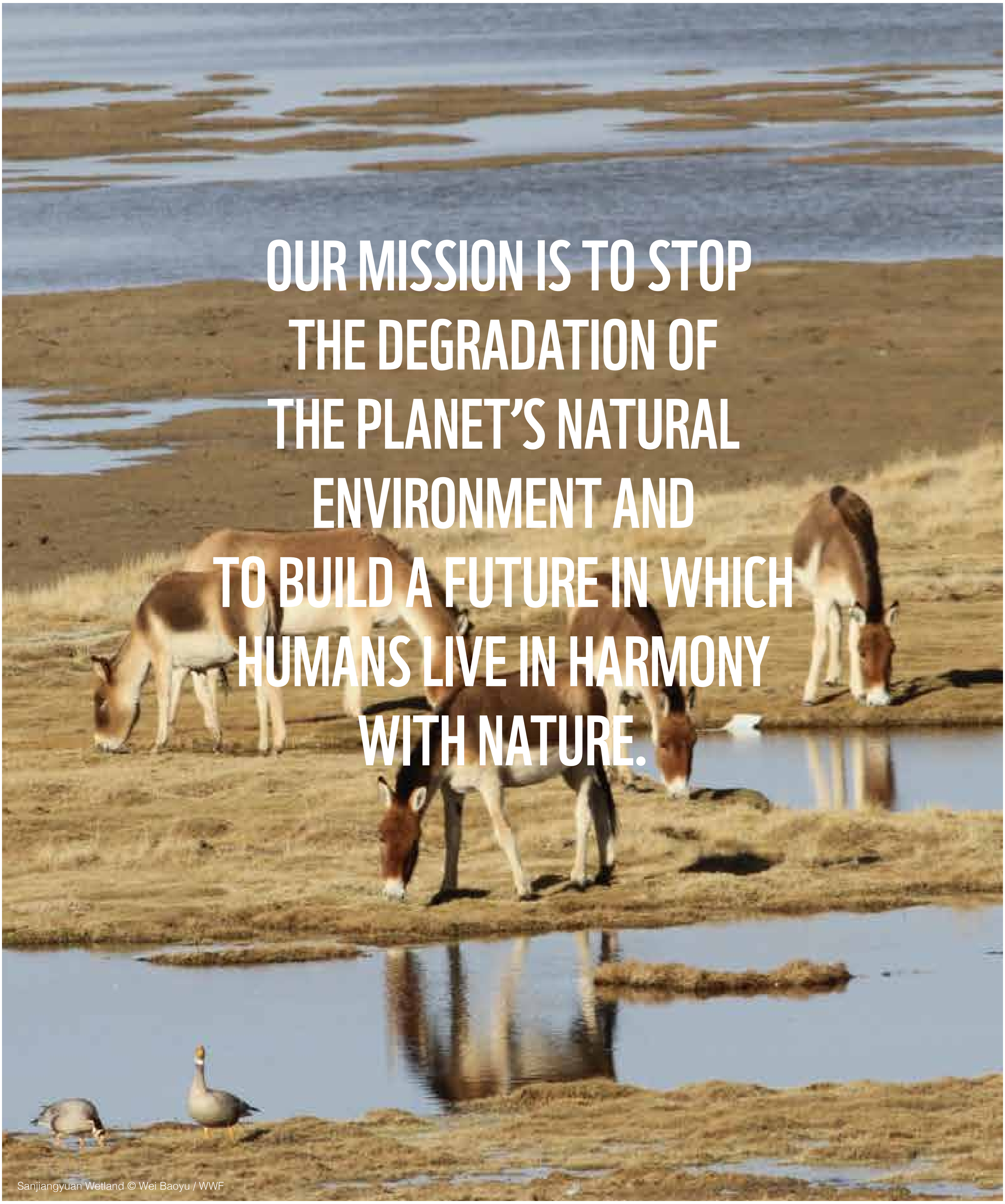
Situated at the intersection of Jiangsu, Zhejiang, and Shanghai, Tai Lake has immense ecological significance in the Yangtze River Delta. The water supply and ecological services provided by the Tai Lake Basin play a crucial role in supporting the regions' green and integrated ecological development. From 2007 to 2020, the Tai Lake Basin underwent its initial comprehensive management phase, primarily focused on source pollution control. Now it has embarked on a new phase of comprehensive and precise management with ecological restoration efforts from 2021 to 2035. Throughout this process, the Tai Lake Basin will strive to establish an environmental governance system led by the government, with active participation from businesses, social organizations, and the public.

WWF in collaboration with the CDP, The Nature Conservancy (TNC), the Pacific Institute (TPI), and the World Resources Institute (WRI), is jointly developing a universal framework of Science-Based Target for Water (SBTW), which can be applied worldwide. The goal is to assist businesses in formulating sustainable water stewardship strategies based on the conditions specific to their watersheds, while also contributing to global water conservation efforts. This framework supports enterprises in developing science-based strategies to mitigate water-related risks and enhance the overall water ecology and security of the entire basin. It promotes a bottom-up model for basin management. The successful implementation of science-based targets has proven instrumental in securing global cooperation. However, the development of the target faces several challenges. Currently, an increasing number of companies are adopting a technology pathway approach to develop Science-Based Target for Water, transitioning from internal water withdrawal targets to integrated water targets that prioritize addressing water use challenges in high-risk basins and maintain consistency with public policies.

To promote and evaluate the implementation of Science-Based Targets for Water in China, WWF and Jiangsu Society Environmental Science (Collaborative Basin Management) chose the Hongda factory of Novozymes, situated in the Tai Lake Basin, afors the SBTW pilot. Water quality and the targets are determined based on the capacity at three levels: factories, urban areas, and basins. This case study employs various approaches including a control unit, calculation of water resources, water environment capacity, pollution control, carrying capacity, and river flux management. Those factors help us to formulate scientifically-informed, hierarchical management targets for water resource allocation, water consumption and discharge, water quality protection, and flow guarantees across the entire Tai Lake Basin and its sub-basins. This enables businesses to comprehend and respond to specific development actions and gain a clearer understanding of their social responsibility in safeguarding the green watershed. These targets bring outcomes that can guide the harmonious development of both industry and basin ecological conservation, serving as the initial step toward achieving world-class ecological lake area management.

Steps for Companies to Develop Science-Based Targets for Water





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