POLYTECH TOURS
Département
Aménagement et Environnement

citeres UMR 7324

université de TOURS

End-of-study Project (PFE) 2020-2021

Towards sustainability, the evolution of restoration projects in Yangtze River, China

Figure 1 Yangtze River, source: britannica.com

Directed by Mr. Karl Wantzen

Student: Mathilda Reynaud

Towards sustainability, the evolution of restoration projects in Yangtze River, China

Yangtze River policy management development and comparison with European model

Research's director
Mr. Karl Wantzen

Author
Mathilda Reynaud

2020-2021

WARNINGS

This research involved readings, surveys, and interviews. All borrowings from interview contents, writings other than strictly personal, all reproductions and quotations are systematically referenced.

The author of this research has signed an attestation of non-plagiarism.

LEARNING BY RESEARCHING, PLANNING AND ENVIRONMENT ENGINEERING END OF STUDY PROJECT

Training in planning and environmental engineering, provided by the Planning and Environment Department of the Ecole Polytechnique of the University of Tours, combines in the field of urban planning, the development of spaces with high to low anthropic content, the acquisition of fundamental knowledge, the acquisition of techniques and know-how, training in professional practice and training through research. The latter does not aim at training the only future students who wish to extend their training through doctoral studies, but while opening this path, it aims first to foster the ability of future engineers to:

- Increase their skills in professional practice through the mobilization of knowledge and techniques, the foundations, and contents of which have been explored as thoroughly as possible to ensure good intellectual and practical mastery,
- Increase planning and environmental engineers' capacity to innovate both in terms of methods and tools that can be mobilized to confront and solve the complex problems posed by the organization and management of spaces.

Training through research includes an individual research exercise, the end-of-study project (P.F.E.), in the final year of engineering students' training. This exercise corresponds to an internship of at least three months, in a research laboratory, mainly within the Dynamics and Territorial and Environmental Actions team of UMR 7324 CITERES, to which the teacher-researchers of the planning department belong.

The research work, whose basic purpose is to acquire methodological competence in research, must accomplish one of the two main goals:

- To develop all or part of a new method or tool for the innovative treatment of a planning problem.
- To deepen basic knowledge to better address a complex planning issue.

To valorize this student's research work, the University decided to input reports judged as good quality into the University Online Documentation System (SUDOC).

ACKNOWLEDGEMENT

First, I want to thank the University and particularly the pedagogic team of Polytech Tours to permit me to develop my thought about another culture. The redaction of this paper was an excellent exercise to increase my mindset and critical thinking. This study allows me to understand a different way to manage river as well to develop another point of view of France case.

In addition, I really thank Mr. Wantzen and this patience and comprehension. The professor was available and shared with me his passion about river environment. This collaboration was an important opportunity for me to study the Yangtze River. His awareness encouraged me to be more conscious about the river management lack in China. Thank to Mr. Wantzen I met Yixin Cao and Tan Chaozhong who contributed to my work.

Thanks to Yixin Cao and Tan Chaozhong to have been concerned and generous. They are involved about the river protection and China development. Thank to their works, I discovered the Yangtze River and all the issues concerning this territory. This paper has been written thank to their studies and knowledge. They were enlisted in my work and guided me during this research. Their understanding was important during my work and it oriented me in the best way to finalize this paper.

This paper tries to show how Mr. Wantzen, Yixin Cao and Tan Chaozhong put a great deal of effort to give to me and to my work an important boost, I am grateful.

TABLE OF CONTENTS

TABLE OF ILLUSTRATIONS

INTRODUCTION

Rivers are central points to the development of a country as they shape the landscape and are a major asset for the settlement of populations. Indeed, they provide essential resources for the preservation of the inhabitants and are an important communication network. If their exploitation globally contributes to economic and political development, it can also lead socio-economic and geopolitical conflicts. However, rivers are nowadays considered endangered environments as they are affected both by overexploitation and climate changes. Thus, the protection of rivers is becoming a major challenge for countries. In addition to their economic interest, rivers have a strong influence on human well-being (Akinsete et al. 2019) and are essential to populations as they represent essential ecological corridors for the conservation of biodiversity. Consequently, river management is an increasingly present issue that is guided by a country's culture. The human-river relationship influences management methods and their development. Indeed, the political choices and the means implemented regarding the protection of watercourses are very different from one country to another. The understanding of different management methods provides a global vision of the place of watercourses within a country. The objective of this study **is to understand the evolution of the management methods implemented for the Yangtze River in China compared to the management policies implemented in Europe**. The aim is to understand the management means implemented by China as well as the methods of restoration and preservation. Comparison with the European model will allow us to understand how public policies reflect the cultural influence of the management methods implemented.

METHOD

Initially, carrying out this research cannot be done without understanding the importance of the Yangtze River in the Chinese culture. To do so, I searched articles devoted to this river trough local medias. I was then able to understand the major place the river occupies throughout the country and its cultural and economic influence. This first step allowed me to assimilate the role of the river as well as the importance of its preservation.

To understand the relationship between man and river and its importance int the population’s habits, I became interested in the different uses present throughout the watershed. During this research phase, I also identified some of the impacts of these different uses and consequently the deficits observed in terms of quality and quantity. I then focused on public policies to understand the management methods used and their objectives.

All this research allowed me to visualize the differences between the Chinese situation and the European situation and thus to compare the actions carried out. I was confronted with several difficulties including the language barrier which prevented me from understanding certain documents. However, many studies were accessible which allowed me to have a global vision of past and current management techniques.

The Yangtze River is a very characteristic river with a length of six thousand kilometers. This makes it the most important river in China and the third longest in the world. Its watershed covers more than two million square kilometers and runs all the way through China, from west to east. The Yangtze River originates from the Tibetan plateau and flows into the China Sea at the city of Shanghai (Z. Chen, Yu, et Gupta 2001). This river has strongly shaped the Chinese landscape and contributed to economic development (X. Xu et al. 2018) (Figure 2). Indeed, the territory crossed by this river is important and allowed the foundation of important cities such as Wuhan or Chongqing. The different landscapes crossed by the river strongly influence its river dynamics by providing it with an important hydraulic force. In addition, the river represents a major economic route as it is a trade route of national importance. Thus, enhancing the interactions between the different territories, it crosses. Different compartments have been defined: The Upstream, the Middle stream and the Downstream. Those compartments are diversely influenced by the economical and, mainly, cultural aspects emanating from populations along the Yangtze River. As a result, we can say that culture is defining the relationship between man and river.

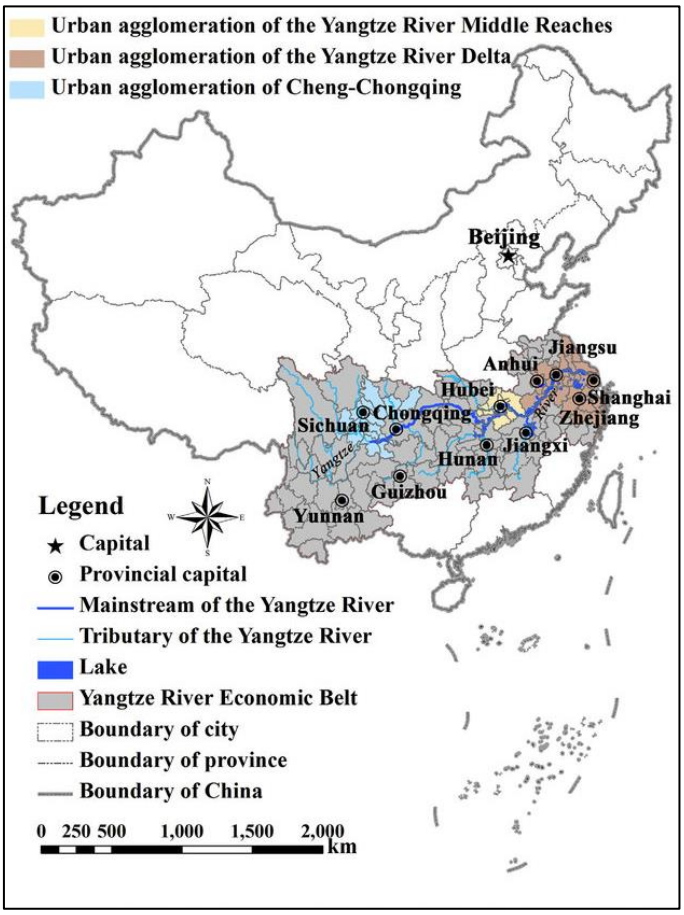

Figure 2 The Yangtze River Economic Belt of China (X. Xu et al. 2018)

The Yangtze River is exploited to respond to various challenges and represents a great asset as well as a major danger for the populations. Chinese economic policy has transformed the river into a major development tool. This trade route has enabled the establishment of large companies representing an essential economic asset for China. However, the territories crossed by the Yangtze River can be characterized by crucial differences in wealth. Indeed, differences can be observed between two cities crossed by the river. This separation between rich and poor populations is strongly rooted and can be observed through access to services considered essential at the European level. For example, wastewater service is not an acquired right and wastewater directly discharged in the river is a recurrent phenomenon. At the same time, companies can also be the source of pollution discharges into the natural environment (Young 2002). In addition to the qualitative aspect of the river being strongly impacted, a fragmentation of the river continuity is also observable. The Yangtze River represents, in fact, an impressive hydraulic force caused by the typology of the territories it crosses. Major events have forced the displacement of entire populations and the installation of dams. The latter contribute to the regulation of water flows but also to the production of hydroelectricity. The Yangtze River has a strong influence on the economic and cultural development of China and its various populations. However, these years of exploitation and the impact of climate change are leading to strong hydrological and ecological changes that may go against the wishes of economic development policy.

These political orientations had a strong impact on the Yangtze River and all the surrounding aquatic environments. The various consequences generated by the degradation of environment and water quality are limiting the use of this river. The implementation of an overall management plan is essential to ensure the coherent development of the entire Yangtze River. The elaboration of such a plan must be comprehensive and take into consideration both the preservation of natural areas and the economic development. The latter is at the origin of an important social inequality within the population which must be taken into consideration when improving the whole system. The protection and management of the Yangtze River are fundamental axes on which fundamental aspects of the population are based: culture and economy.

WHAT ARE THE CURRENT PROBLEMS OF THE YANGTZE RIVER?

Main issues

The Yangtze River belongs to the Chinese culture and is highly regarded by the population; indeed, it is the "Mother of Rivers" (J. Chen 2020) as it is an important source for drinking water and food. The Yangtze River catchment area is home to more than 400 million people (The Nature Conservancy 2010), who can be strongly impacted by the degradation of the river. The exploitation of this river is essential to meet the needs of those inhabitants, which is subject to the resources and services provided, such as electricity, drinking water and wastewater treatment. In addition, the restoration and protection of the Yangtze River is an important health issue as pollutant discharges remain a major problem. This concern must be a priority to protect the population while preserving cultural habits. The Yangtze river valley represents an important territory that concentrates, in addition to the population, considerable biological diversity. In fact, the Yangtze River catchment area includes 49 tributaries and is the source of more than 20 million hectares of wetlands (Lijuan, Manyin, et Weigang 2018). This huge spatial coverage is at the origin of a great diversity of environments and species. In addition, the Yangtze River crosses different territories, which makes it possible to define a sectorization of the watercourse based on geomorphology, thus delimiting the Upstream composed by Riverhead and Upper reaches, the Middle stream with Middle reaches and the Downstream compartment with Lower reaches and the estuary. Each of these compartments are confronted with specific challenges. The Upstream corresponds to the Tibetan plateau and rises to almost 5000m. The Middle stream is located in the center of China and is composed of several plateaus which have an elevation of about 1500m. Finally, the Downstream compartment in the East, corresponds to the mouth and rises to an altitude of 200m (Li, Xie, et Kuang 2001; Ye et al. 2014) (Figure 3).

The source of the Yangtze River is located at the level of the Tibetan plateau which is characterized by an altitude of 4000 to 5500 m. The topographic, climatic conditions and tectonic activity are responsible for erosion phenomena and consequently sediment transport over the entire watershed (Jiang et al. 2020; H. Zheng 2015). This transport is mainly characterized by the presence of magnetite, the origin of which can be determined by monitoring (Jiang et al. 2020). These erosion phenomena cause landslides and may impact populations up to the mouth of the river. In addition, the hydrology of this area causes significant flooding. Indeed, it is characterized by strong summer monsoons. Consequently, reservoirs and dams have been built to limit the flooding risks. The Three Gorge Dam was built in 2003 and is the reservoir with the largest capacity ever engineered. It has a fundamental action of regulating water levels by maintaining a minimum water level in the river and limiting water levels during floods. The monitoring of this installation is vital for the entire population because the slightest weakening of the structure can cause considerable material and human

damage. In addition, this type of dam has a strong influence on the evolution of hydrology and on the quality of both the water and the environment (Magilligan et Nislow 2005). The implementation of this dam as well as the observable climate changes have a strong impact on hydrology: the decrease in flows in the Upstream forces to adapt the operation of the dam in order to meet the needs identified in the Downstream (Gao et al. 2012).

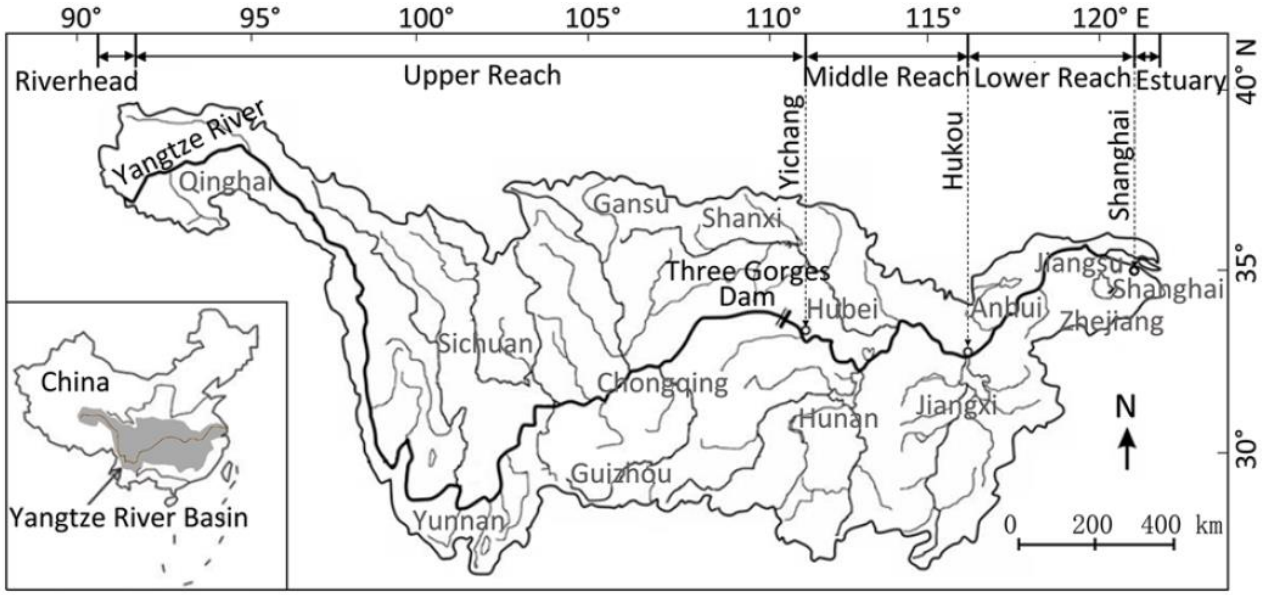

Figure 3 Geographic location and sketch map of the Yangtze River Basin
Upstream: Riverhead and Upper reaches, Middle stream: Middle reaches and Downstream: Lower reaches and estuary
source: Ye et al. 2014.

The Middle Stream compartment of the Yangtze River begins east of the Sichuan Plateau and is characterized by a denser population compared to the Upper stream. The influence of the Three Gorge Dam is considerable and strongly modifies the river geomorphology. In addition, climate change and human activities strongly influence hydrology and water quality. The rapid urbanization of this territory generated by population growth has altered the natural spaces (Gu 2015). The specific climatic context is characterized by heavy spontaneous rainfall which are accentuated by climate changes. Indeed, floods are becoming more and more severe and represent a much greater risk. The increase in these natural risks requires the implementation of increasingly efficient means of protection; however, considering hydraulic changes is essential to have a more resilient system (Cheng et al. 2018). The Three Gorges Dam is a means of protection considered to be unavoidable, but it causes major modifications in the linear of the watercourse. The sedimentary continuity is strongly altered by this dam. Different processes are observable such as a decrease in sediment load while the flow remains relatively stable, leading to progressive erosion of the dam (Ran et al. 2019). The impact on sediment transport also influences the geomorphology of the river. The current dynamics generate instability in the system, which makes it difficult to conceive of future evolution (W. Yuan et al. 2012). Finally, the hydrological modifications generated by the dam influence the hydraulic annexes such as the lakes. Indeed, the regulation of floods prevents the feeding of those lakes. However, these hydraulic connections are essential to the proper functioning of the river dynamic on which various anthropogenic uses are based. The maintenance of these habitats is therefore essential for the economic development of the country (Sun et al. 2012).

The Downstream compartment of the Yangtze River is also impacted by all the above-mentioned characteristics. The climatic influence of the Tibetan plateau is very present and is responsible for significant rainfall (Zhao et al. 2019). Anthropogenic activities generate significant pollution on the entire length of the Yangtze River. This accumulation of pollution, including phosphorus, can lead to eutrophication, which must be considered for development restorations (Müller et al. 2008; Dong et al. 2020). These operations require significant investments, but the environmental benefits will be considerable. Furthermore, the profitability

of the development operations will be satisfactory and proportional to the investments made (S. L. Yang et al. 2006; Strokal et al. 2020). The Three Gorges Dam is a facility that influences the Yangtze River up to its mouth. Various hydrological and sedimentary phenomena are observable as the Downstream is characterized by strong erosion which has an impact up to the delta of the Yangtze River. The annual sediment load has decreased by more than 30% at the mouth of the Yangtze River which impacts the river environments and processes (S. L. Yang, Zhang, et Xu 2007). Erosion caused by this decrease in sediment load affects the riverbed and can disrupt the overall hydrological dynamic. This erosion problems occur on a whole river linear and the impacts gradually increase up to the river mouth (S. Zheng et al. 2018).This instability threatens the equilibrium of the continental shelf by causing landslides.

The Yangtze River is subject to strong anthropic pressure that affect the qualitative and quantitative aspects of this watercourse which represents a great cultural and economic value. The development operations implemented have mainly constrained natural hydrological processes. However, the modification of the functioning of the watercourse leads to the emergence of new problems which aggravate the present situation. It's in this context that the protection and restoration operations must provide a sustainable solution to ensure the hydrological dynamic but also allow a reasonable usage to answer the economic stakes represented by the river. The various problems observed along the Yangtze River make it possible to confirm the central position of this river within the country. Consequently, the implementation of a management policy must be global in order to restore the hydrological and ecological functionalities while protecting the population. The consideration of the latter requires the elaboration of long-term objectives since the risks generated by climatic hazards are more and more important.

Usage impacts

The development of the Yangtze River is integrally part of the economic development of the whole country. It represents a fundamental resource for food consumption, agriculture, and industry. The hydropower it provides is also used for electricity generation. In addition to the use of water, other components of the river are also exploited such as its sedimentary supply.

The country's rapid population growth has led to strong urbanization, which has mainly taken place in natural areas. This dynamic is at the origin of various problems having important consequences on the Yangtze River. The reduction of natural areas, including the hydraulic annexes, has an influence on the hydrological functioning of the river and significantly reduces biodiversity. This urbanization is also defined by a change in land use. Urban areas have increased by 195% between 2000 and 2017 (J. Chen et Qiu 2020), this rapid evolution generates an important sealing of the soils. This has an influence on the overall hydrology of the river. Indeed, soil sealing can be the cause of a reduction in water infiltration and thus a reduction in the level of groundwater. Soil sealing also influences floods by reducing the resilience of these areas and by aggravating the impacts of these events. In addition to flooding, agricultural areas and their sealing can also cause landslides. When these lands are not cultivated, the force of rainfall can be amplified and cause significant damage. Urbanization has necessitated the removal of large amounts of material from the riverbed. The extraction of aggregates within the riverbed has strongly modified the morphodynamic up to the estuary (C. Zhu et al. 2019). These operations, despite their prohibition, are still carried out to provide construction materials (Xinhua 2019b).

The rapid increase of population is also causing an increase in the exploitation of the river. This increase of population makes it increasingly necessary to provide essential services such as access to electricity, drinking water supply and sewage disposal. The latter require major development operations that can have a significant impact on the watercourse. In fact, the installation of hydroelectric dams fragments the river continuum and impacts all the sedimentary processes of the river. The ecological potential of the

Yangtze River is then strongly impacted since the installation of such equipment within the riverbed destroys habitats and the continuity of migration routes. In addition to the ecological aspect, hydrology is also impacted by these dams. The regulation of water flows, and the constraint exerted by the flood protection installations are at the origin of the drying up of the hydraulic annexes. This phenomenon disturbs the habitats but also the entire hydrology of the territory. Indeed, it prevents the natural regulation of water levels between the different seasons, for example. Water quality is also impacted by the different uses of the Yangtze River.

The quality aspect of the Yangtze River is strongly impacted by demographic changes. Industrial activity and the use of water for domestic purposes are significant sources of pollution. Many discharges, although prohibited, are made without any pre-treatment. Those practices oblige public authorities to act against black and odorous water (Xinhua 2019a). This degradation of water quality causes health and ecological problems; in fact, this water becomes too polluted for soil irrigation and destroys the whole ecosystems. Agricultural activity also leads to nitrogen and phosphorus pollution which creates considerable trophic imbalances. The latter are observable at the level of the river but also at the level of the hydraulic annexes which are directly influenced by the hydrological dynamics of the river (G. Yang et al. 2016). In parallel, the introduction of invasive species also contributes to the destruction of local populations. The Yangtze River is exploited for its important supply of fish. On the one hand, they represent a health issue since their quality can be impacted by the pollution present. On the other hand, overfishing is a strong pressure on fish populations. The combination of these three factors leads to a drastic decrease in the biodiversity initially present in the Yangtze River watershed.

All these impacts are influenced by current climate change. These climate changes are caused in parallel by natural dynamics and anthropogenic activities. Indeed, carbon dioxide emissions and global warming are caused by human activities. These changes influence hydrology and require the implementation of increasingly radical means of protection. Climatic events as well as the destruction of natural environments, such as hydraulic annexes, are likely to worsen significantly with the current trend (K. Xu et al. 2007). These climatic evolutions are aggravated by CO2 emissions caused by industries. They modify the climate locally and increase the gap between drought and monsoon periods (N. Zhang et al. 2010).

Policies management

The management of the Yangtze River represents a major economic issue since it is an important river axis for the whole country. However, the degradation of the environment strongly impacts the waterways and thus limits its exploitation. The Yangtze River must be considered in development policies as the disruptions observed in the functioning of the Yangtze River also have an impact on its exploitation. However, the Yangtze River has received little consideration in local management policies. Indeed, this river and its functioning have been little studied, therefore the current evolution of the river dynamics had not been identified.

Contrary to Europe, the management of rivers is not carried out on a global scale, which prevents having a vision encompassing all the problems as well as a coherence on a national scale. This watershed-based management makes it possible to understand the issues that each water body represents and thus make it possible develop an integrated management method. The latter makes restoration projects viable by accentuating the link between each watercourse and the territory it crosses. In China, the very localized management method represents a considerable shortcoming since project implementation cannot be sustained. The World Wildlife Fund for Nature, WWF, is actively participating in the implementation of integrated management of the Yangtze River watershed. The global vision of this foundation makes it possible to apprehend the stakes that this river represents and thus develop a management strategy

(te Boekhorst et al. 2010). The consideration of environmental issues is relatively contemporary, unlike within the European Union. Consequently, the studies concerning the Yangtze River are recent, which has not yet made it possible to apprehend the evolution of the river dynamics following anthropic disturbances.

The management policy of this river shows a gap on different components. Indeed, the consideration at the scale of the catchment area requires to apprehend the whole of the present aquatic environment. Assessing the quality of the ecosystems allows to understand the ecosystem services and to evaluate their importance. They are strongly subject to the hydrology of the whole system. Consequently, water exploitation policy must be an integral part of watershed management but it must be improved to respond in order to the social issues of drinking water supply (Hong Zhang, Jin, et Yu 2018).

The development of the management of aquatic spaces must correspond to the economic development of the country. This parallel evolution must allow a more reasoned exploitation of the watercourse to preserve these spaces. The watercourse management policy must then be transversal between the uses of the water bodies, their consequences and the natural environment's ecosystemic services (Figure 4). This vision must make it possible to detach clear objectives and thus develop a coherent strategy on a national scale. The interest lies into understanding the various problems while following a clearly defined guideline that is understandable by the population, which is a fundamental actor in the management of aquatic environments.

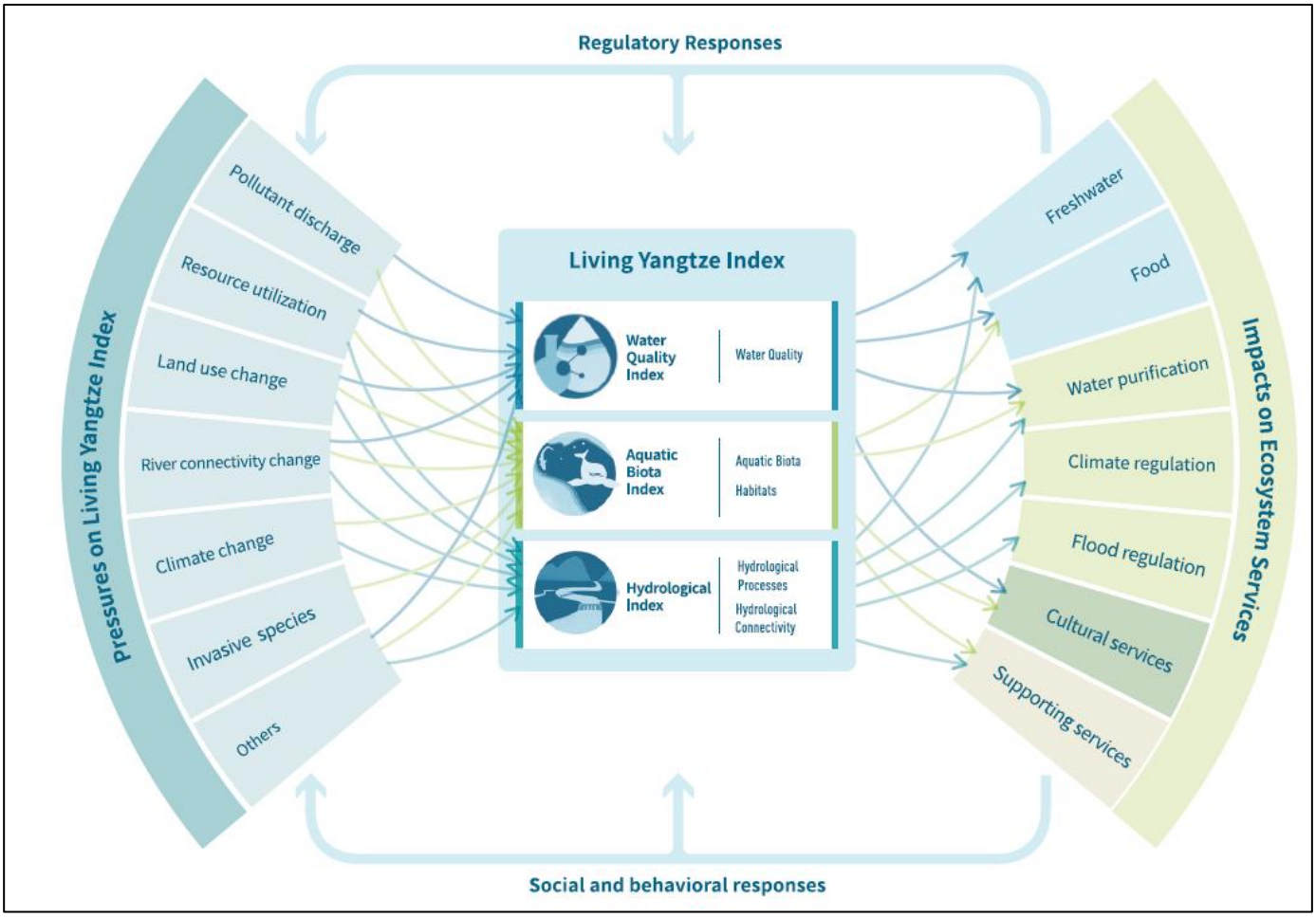

Figure 4 Conceptual framework of the Living Yangtze Report (J. Chen et Qiu 2020)

WHAT ARE ACTIONS TAKEN IN THE WHOLE YANGTZE RIVER BASIN?

The Yangtze River basin is a very fertile economic cradle, forcing public policies to implement effective means of protection to take advantage of its considerable economic benefits. To meet this essential objective, the State must provide major investments amounting to several billion dollars (Xing Yi 2019). To preserve this "gold belt", the Chinese government has set up a strategy for the development and management of the Yangtze River, which identifies the objectives to be achieved and the measures to be implemented (生态环境部 国家发展和改革委员会 2019). The main principles presented in this comprehensive management plan focus on the preservation of the Yangtze River and its cultural significance. The objective is to maintain a strong link between the population and the river while preserving it from external disturbances. At the same time, territorial coherence is essential and can only be established through cooperation between the different actors involved in the management of the river. The development of a river corridor protected from anthropic alterations is essential. Therefore, it is important to create an efficient monitoring network as well as to set up a physical barrier between the river and activities that may degrade the receiving environment.

To meet these objectives, various restoration tools and operations have been put in place. The understanding of the territory is then a priority step, the realization of inventories of ecosystems and species allows to have a vision of the current state of the environments (Cai et al. 2017). The localization of these environment considered to be endangered allows the setup of the monitoring network. The River Chief Policy, RCP, locally contributes greatly to the monitoring and protection of the watercourses for which it is responsible. However, the support of the population by the State is a key factor in changing behavioral habits (She et al. 2019).

The protection of populations must be a balance between respect for river dynamics and the safety of the inhabitants. The concept of Sponge-cities allows the development of resilient cities to reduce the impact of floods. The objective of these cities is to reconcile the inhabitants and the Yangtze River. The concept of Sponge-cities needs to be improved to be transparent to most events (Chan et al. 2018). Moreover, soil protection is a major issue for the whole territory since it can have important consequences for the population. In addition to the human stakes, landslides are also a considerable economic issue since the protection of agricultural areas is important. The solution to this problem is being developed through the Grain to Green Program, GTGP, which consists in restoring landscapes and ecosystems. The objective of this program is to understand ecosystem services and thus develop effective means of restoration. The founding principles of this program is to balance the amount of agricultural land needed for food production and ecological space while limiting the amount of arable land (B. Wang et al. 2017). Experiments are being conducted to address the two issues mentioned above. For example, GTGP implanted grassland along the Yangtze River, aiming to act on hydrology, by limiting flood forces, on ecology, by creating various habitats and on pollution by inducing storage in the soil while improving the overall aesthetic aspect of the landscape (J. Yuan et al. 2021). This solution resembles the grassed strips implemented and mandatory in France since 2005 (Lafitte et Cravero 2010). This example shows difference in the river management between the two countries. This difference is also interesting to point out since the results obtained in France can guide the future development operations of China.

Management policies for the Yangtze River watershed must adapt to the issues identified for each compartment. The exploitation of the Yangtze River has impacted settlements and is leading to a

considerable decrease in biodiversity (T. Chen et al. 2020). The establishment of regional biological indices may be judicious to understand how anthropogenic disturbances affect a local population. The Upper Yangtze River is strongly influenced by the presence of the Three Gorge Dam, which impacts biological stands. Indeed, we observe a drastic decrease of biological stands between 1997 and 2002 (D. Zhu et Chang 2008). Several measures have been taken to restore the Yangtze River to its ecological potential and to respond to the disappearance of characteristic species. Consequently, the regulation or even prohibition of fishing as well as the development of natural areas are important levers for the restoration of populations (H. Zhang et al. 2011).

The development of Chinese cities must be sustainable and limit anthropogenic alterations on the watercourse. The Upper Yangtze River has experienced a significant demographic increase, which obliges public policies to adapt their spatial planning policy as well as their water use. To respond to these issues, it is important to have significant coordination between the different actors in the objective of limiting over-consumption of water. The study of the city of Lijiang has made it possible to implement measures for the management and preservation of natural environments. The main objective is to provide access to water throughout the year to ensure agricultural activity and food for the population. City planning must be oriented towards greener infrastructures, the development of which must be optimized to reconcile water uses and the needs for biological maintenance (Jijun et al. 2018).

The main issues observed in the middle stream of the Yangtze River are related to qualitative and quantitative aspects. Indeed, the most impacting anthropogenic activity is agriculture as it generates significant diffuse pollution and requires significant water withdrawals for irrigation. To significantly reduce agriculture inputs, it needs to be implemented restoration operation could be associated with the reconnection of hydraulic annexes or the recreation of an ecological corridor. Vegetation can have a significant effect on pollutant concentrations while being a suitable habitat for the recolonization of the environment. This rehabilitation method is an interesting solution to address different issues (Wu et al. 2013). This restoration technique is like the plant engineering approach. This rehabilitation technique is based on the capacities of plants to reduce pollution, reduce flooding and so on. (Wu et al. 2013). In France, the use of plant engineering is increasingly popular for the restoration of watercourses.

The Downstream compartment is impacted by all the changes in the previous compartments. In addition, it is subject to significant anthropic pressure caused by overfishing and consequent urbanization. The economic interest of this portion is fundamental for the entire country since it corresponds to a major national and international trade route. However, the degradation of the upper sections is at the origin of many dysfunctions that can limit the exploitation of the river. To reduce the pollution caused by this exploitation, it is possible to rely on the ecosystem services provided by wetlands to absorb phosphorus pollution (G. Xu et al. 2020). Studies carried out on this restoration technique show satisfactory efficiency while allowing the recreation of ecosystems characterized by clean biodiversity.

The integrated management and restoration of the Yangtze River within its watershed is a key economic issue. The Yangtze Economic Belt is dependent on the ecosystem services provided by the various natural areas surrounding the Yangtze River (X. Xu et al. 2018). Development policies must have a global vision of the management of the river and its territory. The exploitation of the Yangtze River must evolve so as not to degrade the aquatic environment. A hierarchy of the different public policies is necessary and must allow for effective cooperation. The objective of this organization is to apprehend the various problems on the scale of the watershed and to act locally at the level of the disturbing source. The legal framework is essential and must limit potential impacts on anthropogenic activities. It is also necessary to implement targeted restoration operations that are consistent with climate change. The preservation of the Yangtze River must then focus on monitoring practices, assessing the state of the river and major action (Y. Chen et al. 2017; Jijun et al. 2018) (Figure 5).

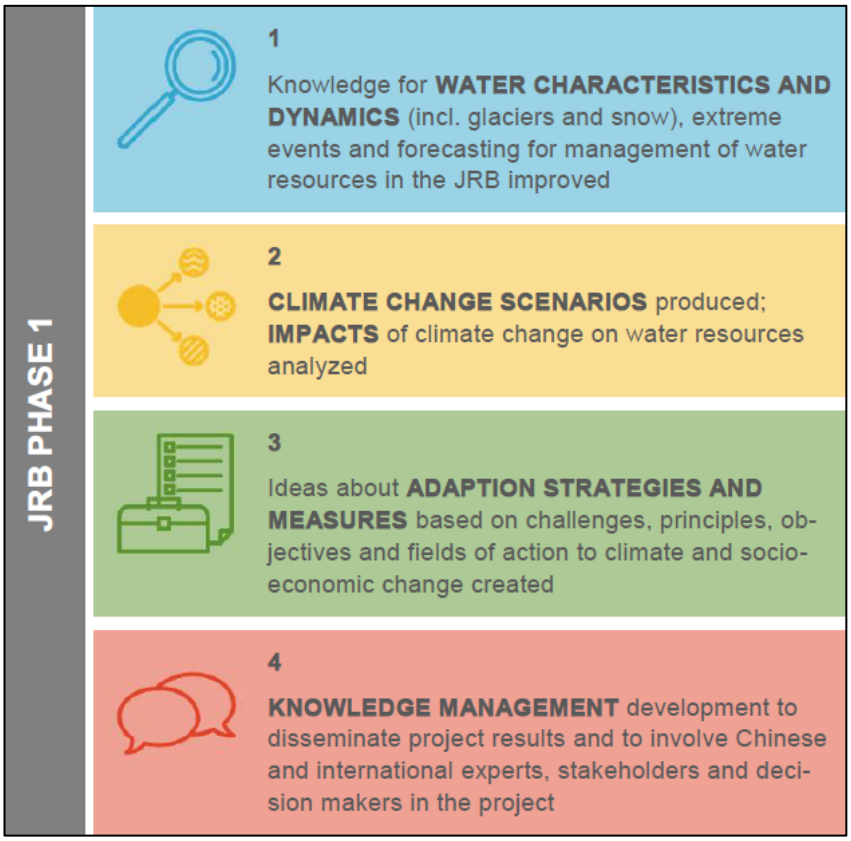

Figure 5 Steps to develop a comprehensive basin management plan - Example of Jinsha River (Jijun et al. 2018)

WHAT ARE THE DIFFICULTIES BEING FACED NOW?

The adaptation of the development objectives of the Yangtze River in China requires the reorganization of all public policies. The latter must define an oriented and precise policy to develop a coherent plan for the whole territory and to have a clear guideline. Beforehand, it is important to understand all the issues at stake in the territory and to visualize and quantify the present disturbances. This first step should allow to understand the issues and define the accessible action levers. Integrated management on the scale of the catchment area will enable the development of objectives to be achieved over the long term, they will guide local actions. The different management structures will then implement means of preservation or restoration to achieve the major objectives set. Cooperation is a key factor for the implementation of such management method. It enables actions to be prioritized and directed towards explicit objectives. In addition, the establishment of a precise legislative framework must limit alterations and must be consistent with the defined objectives.

The evaluation of the current state of the watercourse is an essential preliminary step. It must allow public policy to understand the alterations and to apprehend the actions to be implemented. This inventory must be carried out on different scales since the disturbances can have different impacts depending on the scale taken into consideration (i.e., watershed, portion of watershed or only the river's section). An assessment on a local scale is very interesting since it's the scale that has the most influence on the territory concerned. At the same time, the implementation of a monitoring network must allow to follow the evolution of the qualitative and quantitative state of the rivers in real time.

This administrative organization obliges the Chinese State to provide significant financial support to the management structures. This financial contribution can be a major obstacle to the development of management tools and restoration operations. Indeed, the decentralization of powers forces local public authorities to invest with less financial means. This dynamic can then lead to competition between the various local players. The Chinese government then opted for an annexation of State powers to limit these conflicts and guide local policies (J. Zhang et Wu 2006).

One of the objectives of the preservation of the Yangtze River is to maintain the economic activity that derives from this river. This initiative obliges public policies to make consequent decisions that force the operators to adapt to these new directives. However, the new legislative framework may initiate considerable socio-economic problems. Indeed, the exploitation of the Yangtze River is essential for the local economy but is also at the origin of the degradation of the overall quality of the river and watershed. Public policies must prioritize the stakes and therefore prohibit certain practices. For example, sediment extraction contributes to local economic development but is devastating for biodiversity and ecology. Public policies banned this practice in the 1980s and tightened these measures in the 2000s to prevent illegal extractions. These decisions have destabilized the local economy in several cities and have led to major conflicts (Xiqing, Qiaoju, et Erfeng 2006).

COMPARISON WITH EUROPEAN AND FRANCE SITUATION

The management and preservation of watercourses in Europe is carried out by several managers working on different geographical scales. The aim of this prioritization is to develop a coherent strategy on a continental scale and to respond to similar issues between different countries.

European river policy management

On a European scale, river management is described by the Water Framework Directive, WFD, set up in 2000 by the European Commission. This legislative document sets up cooperation between the signatory countries in the interest of improving and preserving the bodies of water present on the territory. The WFD sets crucial objectives to be respected to respond to the most present problems on the territory. Moreover, it directs public policies towards an integration of watercourses within their river basins, which accentuates the importance of parallel protection of territories and watercourses (European Commission 2014). The implementation of such a legislative framework has led to a significant evolution of river management on a national as well as on a European scale. Indeed, collaborative work has been implemented such as the REFORM project (REFORM 2015) which has enabled the development of cost-effective tools for the restoration of river basins throughout Europe. In addition, collaboration between border regions for the study of watercourses present between two countries is promoted by the Interreg program. Consequently, the preservation of rivers on a European scale makes it possible to make the policies implemented in each country homogeneous, but also to develop means of protection and restoration applicable to different geographical contexts. This founding text has guided the decisions and policies implemented in each European country.

France river policy management

Supported by the WFD, the watercourse management policy implemented in France is based on a hierarchy of several actors acting on different geographical scales. Management by large river basins was initiated in France as early as 1964. It resulted in the creation of the Water Agencies, which are responsible for river basins and their protection. These establishments are at the interface between State services and professionals working on a local scale. The interest of these public entities is to bring together all the actors concerned by the preservation and management of watercourses, including users, professionals, and public authorities. The French Office for Biodiversity, OFB, monitors the quality of water bodies and uses. Under the direction of the Ministry of Ecological Transition, the water agencies, created in 1964, guide the managing actors and provide considerable financial support. They therefore play an active role in the preservation of aquatic environments. Their ambition is centered on the common interest represented by watercourses; indeed, they are at the origin of the territorial coherence of the operations carried out on each catchment area. The power of policing is held by the Basin Prefect, who validates the Master Plans for Water Development and Management, SDAGE, as well as the Water Development and Management Plans, SAGE. These two documents are drawn up by the Basin Committee and guide the development of river basins and set the main objectives to be achieved. On a national scale, EauFrance is a public service to provide updated data on water quality, management set up for each river and so on. The development of such a platform shows the common interest as well as the importance of aquatic spaces.

Local public entities also have a major role to play as they are responsible for the bodies of water present within their territory. The management of watercourses was not anchored in the competences of the municipalities, even though they have a considerable local impact. In 2018, the drafting of the Law on the Management of Water, Aquatic Environments and Flood Prevention, GEMAPI, made it possible to transfer more responsibility for aquatic environments to local authorities. This law was not accepted by all the municipalities, which were not sufficiently supported by the State. Since they do not have this competence, this responsibility has, for the most part, been delegated to a management institution such as the mixed basin syndicates. The latter participate in the preservation of aquatic environments by carrying out restoration operations in compliance with the objectives set by the SDAGE.

The population is also considered to be a major player in the management of water bodies. The creation of basin or river committees and the Local Water Commission make it possible to reconcile environmental protection associations and water users. In addition, the legislative direction taken by the State places the whole population in charge of the quality of aquatic environments. This responsibility obliges public policies to carry out major communication operations.

The policy of Europe and France regarding watercourses and aquatic environments is focused on the protection of the natural heritage thanks to the collaboration of the whole population. This political orientation requires considerable funding, but the overall vision of this management is to reduce future environmental costs. Consequently, it is a policy based on the evolution of aquatic environments and their protection to ensure their long-term sustainability.

Chinese environmental policy

The situation in which China finds itself is characteristic since rapid population growth has forced public policies to take radical decisions. The country's economic development has led to an over-consumption of natural resources. This has led to environmental degradation. This economic growth policy began in 1978 (Balme 2018) with the aim of improving the living environment of the population and thus reducing

unemployment and, by extension, poverty. However, the deterioration of natural areas has led to health problems. The consequences of these political choices quickly damaged the quality of life of the population. It was at the end of the 20th century that China developed a policy to address environmental issues. The first environmental protection laws were ratified in 1989 and aim to reduce the impacts of water and air pollution and so on. and thus ensure a better quality of life for the population (Balme et Renwu 2014). Nevertheless, the implementation of this legislative framework is not sufficient for part of the population. Indeed, the number of Non-Governmental Organizations for the Environment has increased significantly since 2005 (Fei 2015). This trend shows that part of the Chinese population has a strong desire to protect the environment around them.

Despite a political desire accentuated in 2014 by Xi Jinping, maintaining such a directive is faced with national inconsistencies, further fragmenting the country (Balme 2018). However, China wishes to participate in the improvement of environmental conditions and international cooperation. Indeed, the country assumes its responsibility for climate change and accepts the obligations imposed by COP21 (Z. Wang et Wang 2015). However, this instability prevents the country from having national coherence and increases inequalities between territories and populations.

The Ministry of Ecology and Environment, MEE, plays a key role in the preservation and management of the Yangtze River. This institution has become a department within the State and has taken an important position since 2008. It draws up the Ecological Protection Plans in which it outlines the major issues and objectives to be followed (The State Council 2016). At the same time, the management of the Three Gorges Dam is studied each year by this Ministry. Since 1980, the China National Environmental Monitoring Center has been providing data on the quality of the water, the area and so on. Concerning the watercourses, they are classified according to six levels ranging from I for consumable water to VI for water not to be used even for irrigation (Xinhua 2019a).

Evolution on two timescales

The policies put in place by China are strong positions that have today created hitherto unexpected problems for the country. The preservation of rivers is moving towards integrated watershed management like the European model. The development of this new political vision has made it possible to protect 15% of aquatic environments thanks to the Ramsar program among others(J. Chen et Qiu 2020). Emphasized by COPT 21, global cooperation is a major asset for the protection of the environment. China's contribution is essential and will enable the development of international projects to respond to climate change issues. However, the implementation of such a policy must be carried out over several years to stabilize the actions undertaken. Indeed, the European model was developed on strong values and the measures taken have evolved since 1964 and even today some measures are difficult to implement. On this observation, China's environmental policy is recent and must evolve to meet present and future challenges. The drafting of the Law for the Protection of the Yangtze River appears to be a major step forward. It was ratified on 26 December 2020 and will be effective as of 1 March 2021. Its objective is to strengthen the existing legislative framework while providing national coherence. This law promotes coherence between the different compartments of the Yangtze River as well as cooperation between the different managers (Xinhua 2020). This law is an important opportunity for the development of an environmental policy.

RESULTS

Through the research done for this study, I was able to understand how the Yangtze River is fully integrated to his territory and people's mindset. Marked by sudden population growth, China has had to make political decisions to meet the needs of its inhabitants. The exploitation of this river then became a priority to maintain economic development and meet the needs of the population. From then on, the preservation of the river's dynamics has received little, if any, consideration in public policies. This is then the biggest difference between Europe and China, which has not integrated river management into their economic development. This is a political decision that has many socio-economic consequences (Goulard 2016). The degradation of this river has a considerable impact on the economic development it supports. The studies carried out to understand the river dynamics and the impacts generated by overexploitation are recent and guided by the implementation of a management policy increasingly concerned with the preservation of this ecosystem. As for the European policy, it imposes a strict legislative framework since the implementation in 2000 of the Water Framework Directive (WFD), thus allowing the development of a precise monitoring of rivers. On the one hand, this legal text has enabled the implementation of tools, monitoring and protection structures, and on the other hand, it has generated numerous studies on river functioning. These scientific studies now contribute to the evolution of management methods, which obliges the management adapt to adapt to the evolution of knowledge regarding aquatic environments.

The development and preservation of watercourses are strongly oriented by political choices and by the culture of the country. The political direction chosen by China now has dramatic environmental and societal impacts. The current situation is forcing the State to take drastic decisions that may aggravate socio-economic problems. Consequently, the State must position itself as a support to show the interest of such actions and thus legitimize the decisions taken.

DISCUSSION

This study positions itself at the center of the different research carried out and allows to put them in relation. It allows us to take a step back from the research carried out and to have a vision including all the problems observed. The consideration of all the stakes makes it possible to start an integrated management approach of the whole catchment area. However, it is essential that the means implemented for the preservation of the river remain coherent with the place that the Yangtze River occupies in Chinese culture.

The comparison made with the European policy should not then directly influence Chinese policies. Indeed, it is important that China develop his own management policy, which can however be inspired by European model. Coherence is a key factor to ensure the sustainability of the policy to be implemented. At the same time, the effectiveness of restoration operations depends on the State's support of the population to promote the interest of such an evolution of the policies put in place.

CONCLUSION

The "Mother of Rivers" has a central place for the Chinese population; both creator of jobs and initiator of customs, the future of the Yangtze River is a major concern for the whole country. The realization of this study allowed me to glimpse new methods of management and preservation. The protection of the Yangtze River must be a priority for the development of the country, but these new political choices generate important disagreements between the State and the population. Indeed, these decisions taken may seem sudden and then be misunderstood. The European model shows how public policies have adapted and gradually evolved with the problems observed. The actions carried out must also be integrated into an educational action so that the population participates in the sustainability of the actions undertaken.

The different development's temporality can be considered as an obstacle and divided countries. Nevertheless, current dynamic shows a desire to have a common progression to improve daily life of everyone. Rivers and their environment belong to the Human heritage and their preservation seem like be fairer for Human well-being. The environment's consideration must be equitable and concerned everybody. The international cooperation become a powerful tool to impact positively nature conservation.

This study allowed me to understand the cultural influence in the development of rivers. Despite this notable difference, the environmental issues involved in preserving these environments are global. In addition to the intrinsic cooperation of the country, the development of a global strategy for the preservation of natural environments can be a considerable lever for action. This approach was initiated by the Rio Conference organized by the United Nations in 1992. Considering the global interest of these issues is a first step for a coherent evolution of public policies on a global scale. However, there only are few cooperative action plans between Europe and China. The establishment of such a win-win relationship could help accelerate research and thus develop effective solutions.

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