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Research Article

IMPACT OF ENVIRONMENTAL POLICIES AND LAWS ON WATER QUALITY SUSTAINABILITY

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ABSTRACT

This article assesses the impact of the environmental policies and regulations on rivers water quality in China to achieve water resources sustainability. The environmental policies from 1979 to 2015 were divided into five historical stages, and then it compared with the progress of water quality in rivers system. It is noticed that the relative annual progress rate of water quality with a "Good" grade had witnessed a significant increase for the years 1997, 1999, 2003, 2007 and 2012 by 7%, 22%, 24%, 20% and 11% respectively. This progress is linked to the adopted environmental policies and laws at these periods. The result shows the great impact of environmental policies and regulations on water quality progress. The study concluded that adopting strong policies and laws is a major tool to prevent water pollution and achieve environmental protection.

INTRODUCTION

The water management in China has a long history, with evidence of successful experiences and large hydraulic projects stretching back over 4000 years (Calow, et al., 2009). Furthermore, the wisdom and experience of the traditional Chinese society of water governance and management were clearly shown at the historical water rights and irrigation channel management governs.

In the recent years, over the last three decades, China had witnessed incredible economic growth when the Gross Domestic Product (GDP), progress rate, has averaged 9.85 % between 1989 and 2016. However, the impacts of this rapid development have resulted in serious environmental problems nationwide with extensive air, water, and soil pollution. Moreover, water scarcity used to be a serious challenge, according to Yi, et al, China is considered among the 13 lowest water availability countries in the world and the water availability per capita is approximately a quarter of the world average(Yi, et al., 2011).

China water resources are facing many challenges related to water quality and quantity that are critical to the sustainability of these water resources (Liu, et al., 2016; Liu, et al., 2012). Attempt to find a way to solve these challenges largely depends on the successful development and implementation of efficient policies towards environmental protection and sustainable water development (Wang 2010). To a great extent, policies analysts have studied the effects and challenges of water policies related to: economic, agricultural, and technical policies and institutions (Han, et al., 2016; Liu, et al., 2012; Tortajada, et al., 2016; Wang, et al., 2013). From these studies, reasonable policy recommendations were introduced, which support: improving water-use efficiency, treating and reusing wastewater, privatizing water management, supporting water rights, increasing water prices and strengthening policies and involved institutes.

Furthermore, the environmental policies studies are usually based on analyzing the typical characteristics for different phases (Han , et al., 2016; Lian, et al., 2013; Wang 2010). Obviously, this method could help us to further discover the policies development and provide lessons and recommendations for further improving environmental policies analysis and evaluation (Wang, 2010). Yet, through the whole literature, there has been no effort to systematically associate environmental policies with measured data that provide accurate indicators on these policies performance.

Therefore, this paper aims to evaluate China's environmental policies and laws based on water quality data of rivers system, so that can promote fair judgments and draw conclusions for water resources protection and sustainability.

MATERIALS AND METHODS

This study used a combination of descriptive and analytical methods, which was based on data collected

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from the Ministry of Environmental Protection of the People's Republic of China (MEP), formerly the State Environment Protection Administration (SEPA), and the Ministry of Water Resources, of the People's Republic of China (MWR) for the period 1973-2015. The data consist from environmental and water policies and annual water quality data for the main Rivers system. This study used the Rivers system data because Rivers represent the major source of surface water, in addition historical data was not available for all water resources. The evaluation of water quality performance is based on scientific criteria that compared between the progress of water quality and the development of environmental policies and regulations.

According to China "Environmental Quality Standards for Surface Water", The water bodies are divided into five classes based on the utilization purposes and protection objectives (Table 1).

Table 1. Classification of water bodies by functions in China (SEPA).

Water classes	Functions
Class I	Applicable to the water from sources, and the national nature reserves.
Class II	Applicable to first class of protected areas for centralized sources of drinking water, the protected areas for rare fishes, and the spawning fields of fishes and shrimps.
Class III	Applicable to second class of protected areas for centralized sources of drinking water, protected areas for the common fishes and swimming areas.
Class IV	Applicable to the water areas for industrial use and entertainment which is not directly touched by human bodies.
Class V	Applicable to the water bodies for agricultural use and landscape requirement.

Through the history of the environmental development in China, there were many regulations that managed to enhance environment protection arrangements. In this study, the environmental policies studies were divided into five historical phases, based on analysing the typical development characteristics for different. Then, a critical analysis and comparative study have been carried out to link the changes and implementation of environmental policies to water quality performance at rivers system and after that judging the environmental policies development.

A set of statistical analysis were used to identify and show the relationship between water quality and environmental policies. Data analysis was performed with the statistical package acquired by Graph Pad Prism 7 software, and the Relative Annual Progress Rate (RAPR) was used to determine the means and variations in addition to correlate and identify the significance level of the associations by calculating the means and standard deviations for the data. The Relative Annual Progress Rate (RAPR) was calculated based on the following equation:

Relative Annual Progress Rate (RAPR)%=(Xn-X(n-1))/ Xn*100% Eq. (1)

Where: Xn represent the annual progress rate of water quality with Good grade (I - III).

This formula was used to investigate and represent the significant trends of water quality progress. Then, statistical differences of variance across periods were examined. These analyses were conducted to determine whether water quality differed with respect to the adopted policies and laws.

The Historical Development of Environmental Policies

China`s environmental laws and policies had witnessed significant progress and development since 1949. The development of environmental Policies and water quality progress in China between 1949 and 2016 could be summarized in the following five stages:

Extensive construction development without environmental consideration (1949 -1970): There had been many government regulations in place for water and soil conservation, forestry, and safe drinking water from the 1950s and 1960s. However, there were no specific laws for environment protection, since the focus was on the construction of reservoirs, large and medium irrigation districts, and water diversion projects.

As the economy develops, environmental damage increases because of increased human activities, low awareness of the consequence of environmental deterioration, and lack of regulation and intervention for protecting the environment. Therefore at this level, the environmental damage is high and environmental quality is low.

Basic legal framework for environment protection (1970- 1990): In the early of 1970s, China started to realize the hazards of environmental pollution, at that time, almost all the major rivers faced water pollution; many large cities were covered with smog, and the industrial wastes had become extremely serious problems (Wang, 2010). In light of the above facts, the government launched its initial deeds to protect the environment and started taking action to fight environmental pollution.

Therefore, in 1973, China held its first national conference on environmental protection, aiming to deal with factories wastes and in addition to domestic wastewater. One of the main achievements of that period was the issuance of "The Environmental Protection Law of the People's Republic of China", as a trial in 1979 and formally adopted in 1989. The law aimed to control environmental issues such as: prevent the pollution of soil, groundwater, and agricultural products, protect human health, protect ecological environment. Moreover, an especial law was

issued in 1984 for water resources pollution "The law of Prevention and Control of Water Pollution" for both surface and groundwater management.

At this stage, the primary baseline placed on environmental protection with the focus on pollution control and prevention. In spite of the formulation of the two lows for environment protection and water pollution, the situation did not improve since these laws were general and lacked for guidelines and specification measurements.

Numerous water projects were rushed without following the law of environmental protection and have caused massive environmental impacts. The general focus was on the development of large projects based on quantities and not on conservation or efficiency, therefore the total water pollutants discharge was increasing, water pollution was developing from the traditional conventional pollution to the compound types of pollution created from industrial pollution-dominant, sewage pollution-dominant and agriculture pollution-dominant.

Establishment of standards, specifications and guidelines (1990-2000): The performance of environmental protection policies had witnessed many events in 1990s, such as: the modification of the Environmental Protection Law of the People's Republic of China in 1996 and introduced guidelines and specifications and the implementing a program in key catchments and regions to contribute environmental quality improvement in high polluted areas.

After the flood of 1998, the environmental policies include the ecological conservation as seriousness issue and the following policies were implemented: banning the logging of natural forests in the upper and middle reaches; giving priority to ecological restoration at the great development programs; and converting steep arable land back to forests and grassland (Wang, 2010).

There were many efforts took place to formulate legislative details by policy-makers in China at different levels, by 2000 the situation used to be as follow:

• The government formulated 6 environmental laws and 12 resources laws.

• The State Council issued 28 administrative environmental regulations.

• State Environmental Protection Administration (SEPA) formulated 427 environmental standards.

• Provincial government formulated more than 900 local environmental laws and regulations.

These laws and regulations contributed to the establishment of China's environmental legal framework which covers: The controlling of pollutant discharge, pollutant fees policy and energy policy (replacing coal with gas and electricity) (Wang, 2010). On the institutional arrangements, the power of supervision and monitoring of environmental policies used to be run under the National Environmental Protection Agency (NEPA) which was upgraded in 1998 to the State Environmental Protection Administration (SEPA) at ministerial level (Han, et al., 2016).

At this period, after the preparation of environmental legal framework and institutions, the stage of better understanding for the pollution situation was started. The water quality performance in the major river basins used to be very poor during 1996-2000 (Fig. 1).

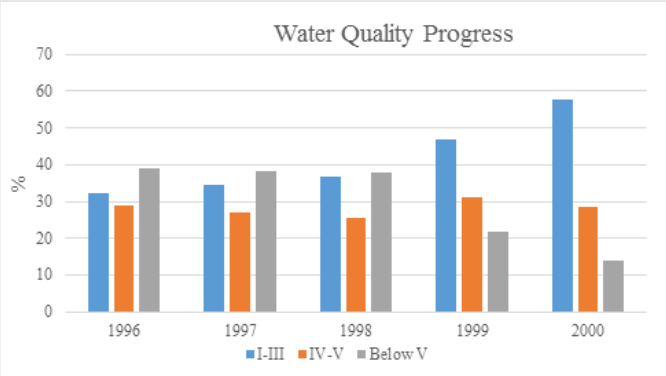

Fig. 1. Water quality classes for rivers system from 1996-2002.

The overall water quality was not steady with ups and downs; Grade I-III was fluctuated around 30%, while the percentage of water worse than Grade V was fluctuated around 35%.

Reinforcement of policies and institutes (2001-2010): The Water Law 2002 outlined the management challenges and policy priorities of water conservation and integrated water resources management. The law described the implementation of policies in surface water and groundwater environments (Calow, et al., 2009). Moreover, the power of Ministry of Water Resources (MWR) in water management has been further strengthened. This main role was to create and implement water allocation and price policy, to oversee water conservancy investments, and to issue water laws and regulations (Wang, et al., 2007).

In 2003, a main environmental law was issued in China that encouraged public participation in environmental decision-making to strength the institutional role in the environment protection. This law was the Environmental Impact Assessment (EIA) Law which main points were:

• Requires all major construction projects to undertake an impact assessment.

• Encouragement of relevant units, experts and the public, to participate in the EIA process in appropriate ways and "should attach explanations for adopting or not adopting the opinions".

• Provided an initial legal cornerstone for encouraging public participation in decision-making processes.

During 2005, the Chinese government acknowledged that 50,000 environmentally related public protests occurred that year. Subsequently, SEPA issued "Measures on Public Participation in the Environmental Impact Assessment Process" in 2006 which clarify the rights and responsibilities of various parties with an interest in the EIA and the forms of public participation and NGOs were generally welcomed to the provisions.

In 2005, on the Songhua River, an environmental disaster occurred when a chemical plant explosion and contaminated the river with 100 tons of oil-related pollutants and toxins. The contamination flowed downstream and affected Harbin city, the capital of Heilongjiang Province and also led to contamination problems along the Heilongjiang River shared by China and Russia. This accident led to new efforts from the Chinese government to take pollution emergency prevention and response requirements more seriously.

Right after the incident, the State Council stated "The Decision on Implementing the Scientific Concept of Development and Stepping up Environmental Protection" in December 2005. This issue highlights the outstanding priority tasks to be solved, such as drinking water safety, pollution control in river basins, and water pollution accident prevention and response.

On January 2006, the "National Plan for Environmental Emergency Response" was announced by the State Council to deal with emergency events causing environmental pollution and ecological damage.

In spite of these efforts, the legislative framework dedicated to emergency prevention and response above are often simple and general. Therefore, in 2007, China's National People's Congress publicized a draft for the new version of "Law of the People's Republic of China on Prevention and Control of Water Pollution, 2008" (This Law was previously adopted in 1984 and revised in 1996), which introduces heavier punishments on both polluters and "irresponsible" administrators and managers. The punishments include fines for industrial offenders and administrative punishments or criminal charges for officials who hide or delay reporting water pollution incidences (Wang, 2010).

Furthermore, towards the efforts of strengthening the environment institutions the State Council in 2008 upgraded the State Environmental Protection Administration (SEPA) to Ministry of Environmental Protection (MEP) with more authorities and responsibilities.

At this stage, after the preparation of legal framework from previous stages, environmental laws and institutions witness strengthen and reinforcement to insure the effectiveness of performance and accelerate the goals achievement. During this period the amount water quality in the major river basins has improved noticeably between 2001 and 2010 (Fig. 2).

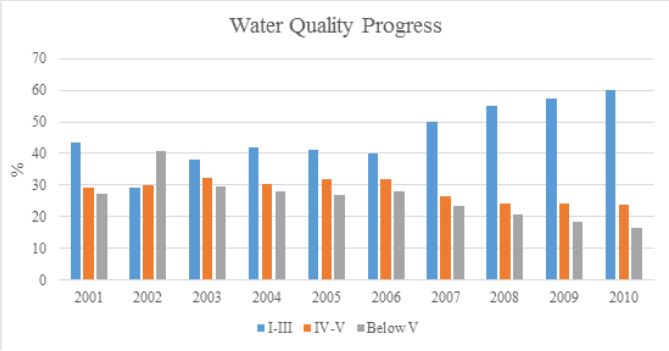

Fig. 2. Water quality classes for rivers system from 1996-2002.

The water quality with Grade I-III witnessed significant dramatically increases from 28% in 2002 to 60% in 2010 (more than doubled). On the other hand, the percentage of sections, worse than Grade V dropped significantly from 40.9 to 16.4% in the same period.

Governmental support and public participation (war on pollution) (2011-Now): The Chinese government announced its most stringent long term water management plan in 2011, known as the "3 Red Lines" water policies that were fully implemented in 2012. These policies aim to address China's regional imbalance in total water use, water use efficiency for industry and agriculture, and water quality improvements, to encourage the sustainability of water resources. According to the plan, the number of water function zones complying with the water quality standard will be more than 60, 80 and 95% for 2015, 2020 and 2030 respectively.

Furthermore, during his first annual policy report in 2014, Premier Li Keqiang described pollution as "nature's red-light warning against the model of inefficient and blind development". Moreover, he went on to announce a "war on pollution" (Wang, 2010). The Chinese Central Government has since declared major policies related to pollution control at the action plan of Water Pollution Prevention and Control "10-Point Water Plan" which was released in April 2015 (Han, et al., 2016). The plan major action points are:

- Control and reduce the pollutant discharge.
- Endorse change of the economic arrangement to lesser pollution intensity.
- Water resources protection through saving water.
- Support science and technology.
- Permit market mechanisms for impact water and pollution charges.
- Strict the environmental law supervision and enforcement.
- Support the overall hydrological cycle management.
- Guarantee water security for environmental and ecological purposes.
- Implement and confirm the responsibilities for all

stakeholders.

• Support the social supervision and public participation.

The plan states new penalties and incentives for water polluting industries through announce lists of poor performing enterprises, and based on annual performance, giving-out 'yellow cards' and 'red cards' (Han, et al., 2016). However, the success of the plan will heavily depend on the cooperation and coordinated implementation among involved institutes.

This plan was followed by significant increase in the financial support, during the Ninth Five-Year Plan Period (1996-2000), China's investment in pollutant treatment was 346 billion RMB which jumped to 2 trillion RMB in 2010 and by 2015, it had more than doubled, reached 4.5 trillion RMB, and nearly 40% was introduced to water pollution control.

After the preparation of legal framework, reinforcement of laws and institutions with sufficient finical support; the government announced "War on pollution", that reflect characteristics of this period and the great attention paying by Chinese government and the public to the environmental protection.

The amount water quality has improved markedly during 2011-2014 (Fig. 3). The overall water quality with Grade I-III raised by 10 percent from 61% in 2011 to 71.2% in 2014, while the percentage of water below Grade V dropped from 13.7 to 9% in the same years. In the previous stages, the policies mainly focused on specific environmental problems solving. Nevertheless, in this stage, the related national policies were more inclined to promote coordinated sustainable development of society, economy, and environment (Han, et al., 2016). It is seems that China has followed the developed countries practices: focus on developing first, and then clean later (Wang, 2010).

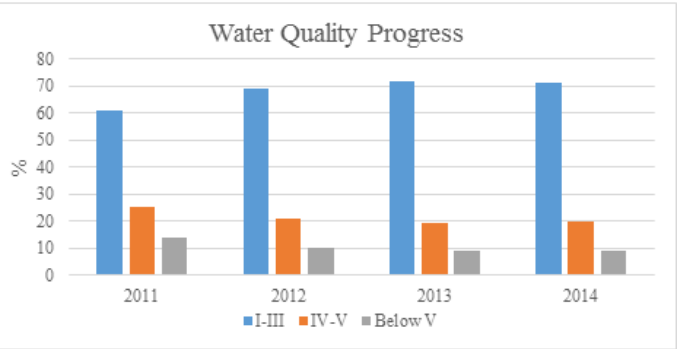

Fig. 3. Water quality classes for rivers system from 2011-2014.

RESULTS AND DISCUSSION

From the previous section, one can see that water quality in China had witnessed many trends through the recent history which could categorized by the extended development. The graph below shows the progress of water quality with "Good" grade, classes (I-III), in China between 1996 and 2014 (Fig. 4). As it can clearly be seen, the water quality percentage had increased enormously during this period.

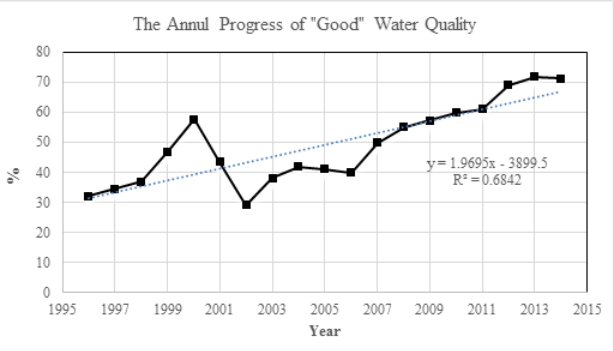

Fig. 4. Water quality trend for rivers system with "Good" grade, classes (I-III), from 1996-2014.

In 1996, the "good water quality" represented only 32.2 per cent of the total amount of water, after that, the water quality declined slightly and reached 29.1% in 2002. Then the level jumped by 9 per cent in 2003 and, over the next years, the levels generally kept growing until reached 71.2% by 2014. Table 2 shows Statistical analysis and difference for Annual Progress and Relative Annual Progress Rate.

Table 2. Statistical analysis and difference for annual progress and relative annual progress rate.

Indicator	Min	Median	Max	Mean	Std. Deviation	Std. Error of Mean
Annual progress	29	46	72	49.4	14.4	3.59
Relative annual progress rate	-24	4	24	4.25	10.9	2.73

From Fig. 4, it could be noticed that the significant development of water quality happened just after introduced and implemented related environment and water policies. The Relative Annual Progress Rate (RAPR) for the years of 1997, 1999, 2003, 2007 and 2012 by 7%, 22%, 24%, 20% and 11% respectively. The Main Environmental and Water policies and water quality progress is shown in Table 3 below.

Table 3. Main environmental and water policies and water quality progress (1996-2014).

Year	Water and Environmental regulations
1996	Law of the people's republic of china on prevention and control of water pollution.
1998	Establishment of environmental specification and standards framework
2002	Water law of the people's republic of china.
2003	Law of the people's republic of china on environmental impact assessments.
2006	Interim measures and public participation in environmental impact assessments.

2008	Law of the people's republic of china on prevention and control of water pollution.
2011	The three red lines' to control water pollution, efficiency, and water use.
2012	The guidelines on implementing the stringent water resources management system.

The statistical results confirm that the environmental policies and arrangements implemented in China's Rivers system had significant impact on water quality progress. The attribute of the environmental progress could be justified when we consider the environmental pollution as a result of economic development (Young, et al., 2015). A commonly cited empirical theory, that identified the development stages of environment quality, is the Environmental Kuznets Curve. This curve could be used to represent and describe the development of environmental policies and regulations (Fig. 5).

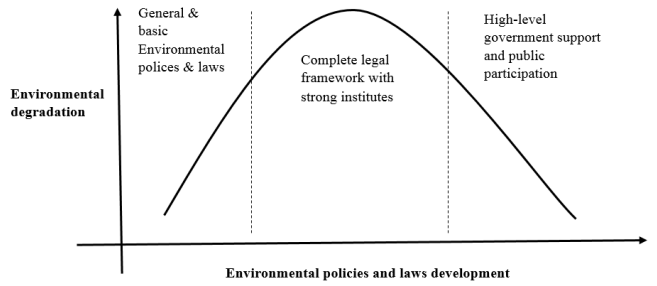

Fig. 5. The environmental degradation vs. policies and laws development.

This theory is based on three phases of policies development, initial, middle and high level. At the initial stage, environmental quality is high because pollution and other environmental damage are minimal due to low level of activities, at this case the pre-industrial period in China before 1949. As the economy develops, environmental damage increases due to the limited policies , the lack of regulation and intervention for protecting the environment, as in the middle-period in China from 1949-2002. Nevertheless, as the legal framework further develop; the environmental quality will increase due to better environmental policies and management in addition to the society awareness and involvement. The year 2002 could be considered as the turning point in of water quality development and progress (Fig. 4). Now China could be classified at the last stage of environment policies development with high-level of attention which includes government concern and public awareness and participation.

However, in spite of these progresses in Rivers system water quality, China's other water resources are still facing many challenges in terms of controlling and monitoring. According to MEP, 9 Lakes are still suffering from high pollution. For groundwater, among the monitoring sites, only 15.2% exhibited as good quality. In the next level, more attention should be paid for lakes and groundwater control and development.

CONCLUSION

Based on the above discussion, it could be concluded that China had well-formed and established policy framework and institutional arrangement for environmental protection and control. The development of these policies had a clear influence on the water quality enhancement for the main Rivers system when water quality with "Good" category increased from 30% in 1996 to 70.2% in 2014.

Although it is true that some policies have failed to be fully implemented, it is just as true that other policies have not only been implemented, but have clearly influenced water quality quantity. Moreover, additional attention should be paid to public participation in environmental decision-making and environmental protection. The general environmental situation in China is under the challenging period and still required more efforts. The study concluded that adoption of strong policies and regulations is a powerful tool to achieve environmental sustainability.

REFERENCES

Calow RC, Howarth SE and Wang J. 2009. Irrigation development and water rights reform in China. *Water Resour Dev*. 25:227–248.

Yi L, Jiao W, Chen X, Chen W. 2011. An overview of reclaimed water reuse in China. *J Environ Sci*. 23:1585–1593.

Liu J, Gao X, Shao W, Han J, Gong J, Niu C. 2016. Water resources monitoring system construction in shanxi province, China. *Procedia Eng*. 154:326–333.

Liu J, Yang W. 2012. Water sustainability for China and beyond. *Science*. 337:649–650.

Wang L. 2010. The changes of China's environmental policies in the latest 30 years. *Procedia Environ Sci*. 2:1206–1212.

Han D, Currell MJ, Cao G. 2016. Deep challenges for China's war on water pollution. E*nviron Pollut.* 218:1222–1233.

Tortajada C. 2016. Policy dimensions of development and financing of water infrastructure: The cases of China and India. *Environ Sci Policy*. 64:177–187.

Wang Y, Chen S. 2013. Policy analysis of agricultural water fee collection in China. *IERI Procedia*. 5:252–257.

Lian F, Song Z, Liu Z, Zhu L, Xing B. 2013. Mechanistic understanding of tetracycline sorption on waste tire powder and its chars as affected by Cu^{2+} and pH. *Environ Pollut*. 178: 264–270.

Wang J, Huang J, Rozelle S, Huang Q, Blanke A. 2007. Agriculture and groundwater development in northern China: Trends, institutional responses, and policy options. *Water Policy*. 9:61–74.

Young OR, Guttman D, Qi Y, Bachus K, Belis D, Cheng H, Lin A, Schreifels J, Van Eynde S, Wang Y. 2015. Institutionalized governance processes: Comparing environmental problem solving in China and the United States. *Glob Environ Chang*. 31:163–173.