

Overview of Prominent Problems in Huai River Basin, China

Review Article

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Abstract

Water resources problem issues have been the focus of increasing international concern and discussions. Water resources are the main economic background of a country. In recent years, the amount of renewable water resources in the world decreased by the increasing number of population and water demand, climate change, pollution, deforestation and urbanization. These problems are still prominent issues in Huai River basin. Generally, the main problems faced in the basin are climate change effect, flooding, water shortage and water pollution. The rate of those problems in Huai river basin is higher than other river basins of China. Since the area is highly productive but the amount of water resources does not satisfy the demand for different purposes. To solve those problems researchers and stakeholders must find a long-term solution by identifying the affected areas. This paper presents the overview of water resources problem of the basin for future study, action plan, and work.

Keywords: Water resources; Climate change; Flooding; Drought; Pollution

Introduction

China is the third largest country in total area in the world and second in Asia with a total area of 9.6 million Km², It covers about 0.067% of the world's total land area [1]. China is the richest country in rivers and lakes, rivers in china extend a total length of 42,000 km, with over 1,500 rivers enjoying a basin area of more than 1,000km². The rivers Basins in China are Hai River Basin, Huai River Basin, Liao River Basin, Pearl River Basin, Songhua River Basin, Yangtze River Basin and Yellow River Basin [2,3]. The water resources in China reached 2.8 trillion m³ but the per capita water resources are only 2,100m³ less than one-quarter of the world average and listed one of the water shortage country in the world [3]. During summer season the intensity of precipitation is high in China and basically the same in each year. The summer monsoon more influenced eastern seashores than inland areas and in summer season the rainfall is increasing from southwest to the northwest [4]. The western part of northwest China has minimum annual precipitation compared to the others. The maximum amount of precipitation occurred mainly from June to September and the lowest in January [5]. Based on the amount of precipitation recorded, in China, the areas divided into the wet, semi-wet, semi-dry and dry area. The special conditions of rainfall and water resources make a country that is frequently suffering from several flood and droughts. From 206BC to 1949 for 2,155 years China was hit by 1,092 major floods and 1,056 major drought [6]. Both surface and ground water are used for different purposes like water supply, irrigation, hydropower generation, industry, recreation etc. In recent years water resources are affected by climate change and pollution and now a day's those problems are big issue and agenda in the world [7]. Huai river basin is one of a river basin in China those problems are faced. In this paper, the main problems in the basin are listed for general

understanding and further study to minimize and control the problems.

Huai River basin

Huai River is one of the main river in China. The river basin drainage area covers five provinces such as Anhui, Henan, Hubei, Jiangsu, and Shandong [8]. The river flow length is 1,000km with the total river basin area of 270,000 km² and the total annual runoff of 62.2 billion cubic meters. The total population is 170 million and total cultivated land is about 12 million hectare [8,9]. From seven river basins Huai river basin is the third largest river basin in population and the main agricultural product producing area of China [10,11]. The geographical coordinate location of Huai River Basin is 30°55'-36°36'N latitude, and 111°55'-121°25'E longitude, as one of the top seven river basins in China [8-12]. Figure 1.

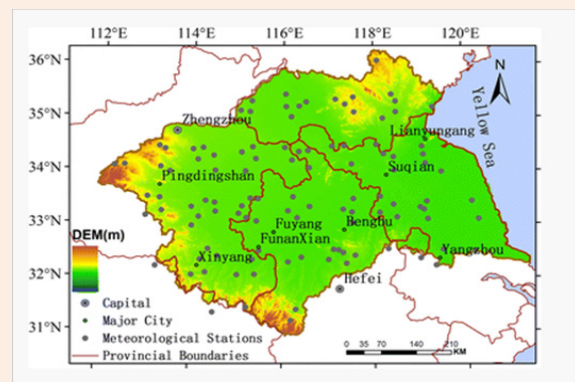


Figure 1: Map of Huai River Basin [24].

Discussion

Water resources in Huai River basin

The world top six countries in terms of the amount of annual runoff are Brazil, the Russian Federation, Canada, United States, Indonesia, and China [13]. From this China is the sixth water resources abundant country in the world but the country faces many water resources problems and challenges. The total number of population in China is nearly 1.3 billion and this large number of the population affects the per capital amount of water resources. The average world per capital amount of water resources is around one quarter. This result shows water shortage is the main problem in China [2-14]. In Huai river basin the annual rainfall decreased by 6% [14]. In the River Basin, there is a mismatch between water resources distribution, population, farmland and gross domestic product (GDP). From the total annual runoff of 62.2 billion cubic meters the water resources distribution is 3.4% [15]. The unbalance between population and farmland caused water resources shortage in the basin. The main problems in the basin are water shortage, flooding and water quality. To control water shortage and flood in the basin floodgates and dams were constructed greater than 5,000 and 5,700 respectively [15].

General prominent problems of Huai River basin

Climate change: Global climate change impact affects the water resources availability in the northern part of China. In the little decade year deforestation, agricultural and urban development, construction of large hydraulic structures and groundwater level drawdown are the main impacts of human activities on runoff generation and climate change in the world [16,17]. In China the average annual temperature up to 2030 will increase by 0.32°C. This effect is more in the northern part of China than southern part. Huai river basin is one of a river basin located in the northern part of China. Due to climate change the annual mean runoff of Huai river will decrease by 10.5% up to 2030 [7]. Water storage index and water demand index are the two methods indicated the risk of water resources systems. The water shortage index (S/Q) is more than 0.6. This result shows that during drought year there is no water to be stored in the reservoir. The water demand index (D/Q) is above 0.5, this means the water demand is greater than

the annual runoff in a river [7]. According to this result due to climate change effect the water resources system in the basin is at risk.

Water stress: Water stress occurs when the amount of water flow is low. In the river basin, the water resources pressure has increased because of population growth and water demand. Relative to upstream and middle stream river reach the pressure is high in the downstream reach of the river basin [18]. The shortage of water resources due to low rainfall and runoff and the uneven spatial distribution have been the cause of water stress in Northern China [19]. The previous research result shows that the amount of runoff in the basin is declining trend during recent decades. During 1956 to 1979 in Huai, Hai and Huang/Yellow river basin the annual average precipitation, runoff and flow to the ocean decreased by 9.6%, 23.8%, and 58.6% respectively [20,21]. This result shows the water stress is more in the lower reach of the basins because the percentage of flow to the downstream reach of the basin is decreased around by 60% [20,21]. The following table shows the spatial distribution of water resources in the north and south part of China. The river resources zone included in north region of china are Hai, Huai, Hang, Northwest and Song-Lia and in the south zone are Pearl, Southeastern, Southwestern and Yangtze [19] Table 1. According to the assessment of the Chinese Academy of Science [22], in Northern China during 1988 to 1999, percentage of vegetation coverage from the total land decreased from 38% to 32%, and urbanized area increased from 8.2% to 9.5% (varying over eastern, western and central parts). Due to population growth in the river basin agricultural lands in the urban areas have been converted to urban and in mountain areas, forest and grassland are being replaced by cropland in the rural area. This Land use and Land cover change reduces soil water storage and increases flooding. In Northern China, the practice of construction and developing of hydraulic structures to store and redistribute water for different purposes has used for water resources management. A large number of hydraulic structures have been constructed to store and control the runoff in the region [23]. Generally, the water stress problem in Northern China due to population growth, agriculture, water quality and industrial and municipal development should be evaluated in a water resources management and planning perspective view.

Table 1: Total average annual renewable water resources at regional level (Sources: [15]).

Location	Total Average Annual Renewable Water Resources		Population		Per Capita Water Resources (m ³)
	Billion (m ³)	%	Million	%	
North China	535.8	19.1	592.4	45.2	904.1
South China	2276.6	80.9	694.7	53	3279.6

Flood and drought: Flood is a phenomenon varies from place to place and occurs erratically in time. A high flood occurs due to intensive rainfall. In China Flood and drought occurred frequently and they are the major natural hazards. The previous study result shows, during the period of 206 BC to 1949 AD droughts and floods occurred 1056 times and 1092 times, respectively. The frequent occurrences of major drought and

flood events are every two years on the average [15]. The main factors affecting the occurrence of floods are deforestation, soil type, the slope of the catchment, poor drainage system, climate change, sedimentation, topography and river drainage, and human activities [2]. In Huai River Basin from 1994 to 2007 flood was caused by the accumulation of precipitation and occurred for more than ten times. In the previous two years because of

high rainfall intensity in the basin within five and eleven days of precipitation accumulation flood occurred in 1975 and 1991 respectively. Drought occurred for more than eight times from 1959 to 2001 [24]. Therefore, the probability occurrence of the flood is greater than droughts in the River Basin [5]. Drought is occurred due to less amount of precipitation over few months or more. In drought years especially agricultural lands are affected by water shortage [24]. Water resources infrastructures were built to control the frequency of flood and drought disaster. In the river basin the problem is not only the quantity of water, currently water quality also the important issue. The water resources problem is as a result of population growth, deforestation, economic development, industry development, urbanization and waste water disposal. Generally, water problems and challenges in Huai River Basin include three major types such as maximum water flow floods, minimum water flow droughts, and poor water quality (below WHO standard) water pollution [15]. From 1959 to 2008, the rate of precipitation risk in the basin was low in the central and high on the eastern. During this period of time disaster causing threshold and agricultural area in Huai River Basin [24].

Water Pollution

Caused by municipal, industries and agriculture: Water pollution is the contamination of water in rivers, lakes, oceans, aquifers, and groundwater. It caused when pollutants are discharged directly without treatment into the water bodies [25]. Water bodies in China due to the result of rapid economic

development, industrialization, population growth and agricultural expansion have been polluted and the water quality is below the standard in the past two decades to use the water for different purposes. In Huai river basin the water pollution began In the 1970s but seriously increased after the 1980s [26]. The waste disposals from industrial, municipal and agriculture are main pollutant sources [27]. The main pollutants in the Huai River Basin are NH3-N (2.66 tons) and COD (38.2 tons), and the total amount is greater than the standard. In 2008, the amounts of NH3-N and COD were 0.74 and 2.05 times more than the limits, respectively. In 2000 the total amounts of pollutants discharging to the river were nearly 30% because Huai River Basin is the major grain producing area. Most of the rivers are seriously polluted because of excessive pollution loads [28]. From 1994 to 1998 the percentage of water safe for drinking is 20 and the percentage of water non-suitable were greater than 60 [29]. The monitoring of water quality status of the basin from 1994 to 2005 has shown the water quality of the river was worse than the other river basins. Thus, water quality management and control are essential in the Huai River Basin [28]. In 2011 the amount of water used for drinking and recreation purpose is less than 50% that means the water quality standard class I-III [14]. This result shows the quality of the water was decreased and it needs an action Plan to reduce and prevent pollutants. In China, surface water quality is graded based on pH-value, dissolved oxygen, biochemical oxygen demand (BOD), nitrogen, and ammonia. The surface water quality is graded on six-grade scale [30]. The following table shows the surface water quality standards in China Table 2.

Table 2: Surface water quality standards (Source: Ministry of Environmental Protection of the People’s Republic of China [3]).

Grade	Classification or Applicable Uses	Remark
I	Pristine water sources	Grade I and II-for drinking water supply
II	Class A water source for drinking supply	
III	Class B water source for drinking supply and recreation	
Iv	Industrial and recreational water supply with no direct human contact	
V	Limited agricultural water supply	
VI	Essentially useless	

Caused by hydraulic structures (dams and floodgates): In the world, several countries and regions faced different water quantity and quality problems that are common globally in water resources management. In China especially the water pollution has the result of rapidly economy and population growth and construction of the excess number of hydraulic structures for flood and drought control [2]. In Huai River Basin More than 5,700 dams and 5,000 flood gates have been constructed to control flood and drought. To control one-third of the total drainage area in the basin there are 36 large reservoirs. Based on the storage capacity there are approximately 600 large and middle scale dams in the basin. The total storage capacity of flood control structures in the basin is 303 billionm³ with active storage of 150m³. The purpose of dams and floodgates in the basin is for water supply, navigation, recreation, irrigation, flood control and electricity generation

[31,32]. In the wet year (1991), Hydraulic Structures were open for flood control and the impact was not observed. However, in the dry year (1999), the hydraulic structures were stored water to satisfy the demand of water need in the upper reaches. Because of high population density and the excessive dam and flood gate constructions in the basin hydrological regimes and discharge of pollution load increased continuously. The impact of hydraulic structures has negative in the middle and lower reaches and positive in the upper reaches of the basin [32].

Conclusion

The major water resources problems in the basin are a minimum and high amount of water flow and poor water quality (below the standard). In the Basin there is less amount of water

resources for irrigation, municipal and industrial purpose, this inadequate water resources demand can practice water pressure in the basin. In China, due to the result of rapid economic and industrial development, population growth and agriculture expansion, the water bodies have been polluted and the water quality is below the standard in the past twenty years to use the water for different purposes. In 2011 the river water used for drinking purpose was less than 50%, this result shows the quality of water was decreased and it needs water resources management and planning in the basin to reduce the pollutants and to satisfy the water need for different purposes. Flood was caused by the accumulation of precipitation and a lot of hydraulic structures are constructed in the basin to control flood and drought but those structures affect the water quality of the river.

Recommendations

The problem of water resources in the basin is the major topic in the world. The main problems in Huai River Basin are flood, water shortage, and pollution. To solve this problem each and every users have a responsibility to work cooperatively with the concerned bodies. The following points are the recommended solutions to solve those problems.

1. Allocate the water properly to all users.
2. Use potential water sources parallel (Groundwater).
3. Use pond water for irrigation purpose.
4. Treat industry disposals before discharging to the river.
5. Treat irrigation drainage water.
6. Test, treat, monitor and supervise the water quality of the river regularly.
7. Apply integrated river basin management.
8. Apply water resources planning and management.

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Conflicts of Interest

The authors declare no conflict of interest.

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