Present Situation and Suggestions of Groundwater Over-Exploitation in Hebei Province

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Abstract

Human survival and development are inseparable from the resources and environment required. In order to create better living conditions and for continuous development, people always try their best to obtain the necessary resources. By exploiting groundwater, changing groundwater resources and the environment, To meet the needs of production and life, at the same time, groundwater resources and environment are restricted by human population development. If groundwater resources and geological environment functions are coordinated and stable, people's activities must be within the capacity of groundwater resources and environment. . In recent years, with the improvement of production and living standards, the rapid development of the economy and society, the demand for water resources has also increased greatly, the demand for groundwater has increased, and the pace of people's exploitation of groundwater has been greatly accelerated, resulting in excessive exploitation of groundwater. The situation is getting worse and worse, and the groundwater system has undergone tremendous changes. This paper takes Hebei Province as an example to analyze the current situation of over-exploited groundwater, studies the effects of over-exploitation groundwater, and proposes measures to deal with over-exploitation of groundwater.

Keywords

Hebei Province; Groundwater over-exploitation; Countermeasure analysis.

1. Status of Over-Exploited Groundwater

In the current people's lives, the application of groundwater has become a normal phenomenon. Not only have people actively applied groundwater rationally, but they have also extensively developed other functions of groundwater. Therefore, the area of groundwater exploitation in China has been increasing and has covered a considerable area [1]. At the same time, due to the accelerating speed of groundwater exploitation, the groundwater supply in many areas is difficult to meet the actual water demand, and then the phenomenon of water volume reduction and collapse occurs. In severe cases, the groundwater in the region will be depleted. Not conducive to people's normal water use. The impact of over-exploited groundwater on the hydrogeological environment is the most direct. It will cause a serious funnel area in the area where the groundwater is located, which will lead to settlement on the ground and pollution of water resources. This method of groundwater exploitation has become a normalization phenomenon, taking Hebei Province as an example.

1.1 Groundwater Over-Exploitation in Hebei Province

Hebei is a typical resource-based water-deficient province, and the only province in the country that does not have a large river crossing. The total amount of water resources is seriously insufficient, and the water resources of passengers continue to decline. The average annual water resources is 20.5 billion m3, and the average per capita is 307 m3, which is only the national average. 1/7[2] of the value.

According to the actual amount of groundwater in the base year of the current year, according to the over-exploitation of the cross-prefecture administrative district in the third-level water resources zone, the groundwater over-exploitation in the province in 2013 was 59. 65 × 108 m3, of which shallow

groundwater was over-exploited 28.68 × 108 m3, deep water 30. 97 × 108 m3 [3]. According to the city and rural areas, the city over-exploitation is 18.94 × 108m3, and the rural over-exploitation is 40. 71 × 108m3. The current over-exploitation of each administrative division is shown in Table 1.

Table 1. Hebei Province Groundwater Super-exploitation Scale /108m3

District city	Shallow groundwater	Deep confined water	Total	Urban over-exploitation			Rural over-exploitation				
				Shallow groundwater	Deep confined water	Subtotal	Shallow groundwater	Deep confined water			Subtotal
								Subtotal	Rural living	Rural irrigation	
Handan	1.74	1.82	3.56	0.43	0.36	0.79	1.31	1.46	0.78	0.68	2.78
Xingtai	2.61	3.33	5.94	1.57	0.78	2.35	1.04	2.5	0.42	2.13	3.59
Shijiazhuang	7.86		7.86	3.36		3.36	4.5	0			4.5
Baoding	7.08	0.10	7.18	2.64	0.1	2.74	4.5	0			4.45
Hengshui	1.00	9.22	10.22	0	1.77	1.77	1	7.45	0.49	6.96	8.45
Cangzhou	0.08	6.89	6.97	0	1.1	1.1	0.08	5.79	1.06	4.73	5.87
Langfang	0.50	2.90	3.40		1.92	1.92	0.5	0.98	0.7	0.28	1.48
Tangshan	2.50	2.60	5.10	1.28	1.29	2.57	1.22	1.31	0.45	0.86	2.53
Zhangjiakou	1.30		1.30			0	1.3	0			1.3
Dingzhou	1.77		1.77	0.21		0.21	1.56	0		0	1.56
Xinji	0.84	1.10	1.94		0.26	0.26	0.84	0.84	0.15	0.69	1.68
Wei County	0.26	0.38	0.64		0.03	0.03	0.26	0.35	0.16	0.19	0.61
Ningjin County	0.29	0.47	0.76		0.12	0.12	0.29	0.35	0.14	0.21	0.64
Zhuozhou	0.85		0.85	0.33		0.33	0.51	0			0.51
Renqiu		1.11	1.11		0.31	0.31	0	0.8	0.08	0.72	0.8
Jing County		1.05	1.05		0.14	0.14	0	0.91	0.07	0.84	0.81
The province	28.68	30.97	59.65	9.82	8.18	18	18.86	22.79	4.51	18.28	41.65

1.2 Distribution of Over Mining Area

According to the Notice of the People's Government of Hebei Province on Promulgating the Scope of Groundwater Over-exploited Zone, Forbidden Mining Zone and Limited Mining Zone in the Plain Area, the area of groundwater over-exploitation in the plain area of the province totals 66779 km2, accounting for more than 91% of the province's plain area. . According to the degree of over-exploitation, the area of general over-exploitation area is 38143 km2, and the area of severe over-exploitation area is 37771 km2. According to burial conditions, the area of shallow over-exploitation area is 33812 km2, and the area of deep over-exploitation area is 42102 km2. Deep and shallow over-exploitation The area overlap is 9134 km2 [4].

(1) The super-mining area of shallow groundwater totals 33812 km2. Among them, the general over-exploitation area is 28685 km2, and the severe over-exploitation area is 5126 km2.

(2) The area of deep groundwater over-exploitation area totals 42102 km2. Among them, the area of the general over-exploitation area is 9457 km2, and the area of the severe over-exploitation area is 32644 km2. The results of the division of groundwater over-exploitation zones in Hebei Province are summarized in Table 2.

2. Impact of Over-Exploitation of Groundwater

The plain area is the main development and utilization area of groundwater, and the environmental problems caused by unreasonable mining are also mainly distributed in this area. The plain area of Hebei Province is in an over-exploited state. Over-exploitation causes a series of water environmental problems. The shallow groundwater distribution area mainly includes aquifer dewatering, shallow groundwater level falling funnel, ground subsidence and ground fissure. The deep groundwater distribution area is mainly characterized by deep groundwater level falling funnel, land subsidence, sea (salty) water intrusion, etc. [5].

Table 2. Summary table of groundwater over-exploitation area in Hebei Plain /km2

Administrative division	Shallow over-exploitation area			Deep over-exploitation area				
	Subtotal	Serious over-exploitation zone	General over-exploitation area	Subtotal	Serious over-exploitation zone	General over-exploitation area	Deep and shallow overlapping area	Total area of over mining
Shijiazhuang	5767	1042	4725	78		78	77	5767
Handan	6378	1630	4748	4244	3172	1073	4089	6533
Xingtai	3283	391	2892	5053	3981	1072	384	7953
Baoding	8939	942	7997	1350	290	1060	1350	8938
Cangzhou	525	0	525	13033	12982	51	525	13033
Langfang	2435	193	2242	3693	2540	1153	136	5992
Hengshui	1066	0	1066	7437	7135	302	630	7873
Tangshan	823	237	586	2977	317	2659		3800
Dingzhou	1274		1274					1274
Xinji	951		951	794		794	794	951
Wei County	851	66	785	851	625	226	851	851
Ningjin County	778	626	152	628		628	299	1107
Zhuozhou	742		742					742
Renqiu				1023	661	362		1023
Jing County				942	942			942
Super mining area total	33811	5126	28685	42102	32644	9457	9134	66779
On Zhangjiakou Dam	3899	4	3895					3899

2.1 Partial Dewatering of the First Aquifer Group in the Piedmont Plain

As the shallow groundwater level in the plain area of the Taihang Mountains has continued to decline year after year, the groundwater depth in the area south of Shijiazhuang Shide Railway, north of Xingtai City and east of Ningjinpo ~ Continental Ze is generally around 30. 0 m. More than 40. 0 m, which is lower than the bottom depth of the first aquifer group in this area, and the water-bearing group is basically drained.

2.2 Groundwater Appears to Drop the Funnel

The funnel area is a kind of collapse phenomenon in the hydrological environment. It is mainly due to the decrease of the groundwater content, and the groundwater itself is a kind of support of the earth's surface, so the mining speed needs to be balanced. However, in the actual mining work, in order to obtain economic benefits, the groundwater resources were unregulated in an uncontrolled manner, resulting in a large loss of water resources in the region. Due to the lack of direct support of groundwater, the surface became very weak and began to show a funnel-like geological condition. The emergence of this situation indicates that the over-exploitation of groundwater is very serious, forming a higher degree of land subsidence. Since the area of groundwater is generally concentrated at the same point, and the groundwater at this point is drastically reduced, the resulting collapsed condition will show a more pronounced funnel shape. Therefore, people neglect the recharge capacity of groundwater in the process of groundwater exploitation, so that the overall content of groundwater is rapidly reduced, and it is difficult to meet the actual demand, which will directly lead to the occurrence of ground collapse [6].

At present, a number of perennial shallow groundwater level dropping funnels have been formed in the plain area of Hebei Province, mainly including Shijiazhuang funnel, Ningbailong funnel, Gaochunqing funnel and Suning funnel. At the end of 2013, the largest Ning Bolong funnel area was 1746 km2, and the center buried depth was 73.12 m. Due to long-term over-exploitation, the deep

confined water funnel formed includes the Yinzhou funnel, the Hengshui funnel and the Nangong funnel. The deep-contained water level falling funnel with large influence and long formation time mainly includes the Hengshui funnel and the Yinzhou funnel. At the end of 2013, the center of the Hengshui funnel was 84.7 m deep and the funnel area was 247 km2; the depth of the funnel center of Zhangzhou was 78.1 m, and the area of the funnel area was 955 km2.

2.3 Local Cracks Appear in Local Areas

A large amount of groundwater is pumped out, so that the original aquifer is drained, the buoyancy of water is lost between the geotechnical particles, and a large amount of pumping carries a certain amount of sediment, which increases the pores, and cracks occur under the weight and structure. . There are a total of 43 ground fissures in the province, mainly distributed in the central and eastern plains. Typical, such as Xiwang Town, Baixiang County, is 8 km long and 70 cm wide; Wen'an County has a length of 1 km, a width of 60 cm and a depth of about 4 m.

Generally speaking, there are certain understandings and researches on ground fissures caused by groundwater exploitation at home and abroad. However, the specific genetic mechanism of groundwater over-exploitation to ground fissures is still inconclusive, especially the understanding of ground fissures in China is not yet mature. There is a lack of long-term monitoring and research work abroad and a large number of indoor and on-site experiments. The investigation of the genetic mechanism of ground fissures is generally subjective and random, and lacks more in-depth analysis and argumentation [7].

2.4 Large Area Land Subsidence in the Plain Area

Due to the excessive exploitation of groundwater, land subsidence has occurred in 46 cities across the country. The cumulative maximum settlement of the settlement centers in Shanghai, Tianjin and Taiyuan City exceeds 2 m, and the maximum settlement of individual points in Tianjin Tanggu has reached 3.m. Ground cracks have been produced in the Hebei Plain, Xi'an, and Shanxi, and pose a serious threat to urban infrastructure construction. In Xi'an, the continuous decline of the groundwater level induced and aggravated the development of land subsidence and ground fissures. The city formed seven relatively large water level funnel areas, and 11 large ground fissures appeared [8].

Due to over-exploitation of groundwater in the plain area of Hebei Province, the dewatering of aquifers has caused hidden dangers such as land subsidence and ground fissures. At present, 482 ground fissures have been found, affecting 7 provinces and nearly 70 counties (cities). The serious land subsidence area in Hebei Province is mainly concentrated in the central and eastern plains. At present, it has developed into 8 high-value areas for settlement, namely, Zhangzhou, Renqiu, Bazhou, Langfang, Baoding, Hengshui, Nangong, Feixiang, etc. The hill is the most serious. 5 m. The cumulative settlement of the city of Cangzhou City has exceeded 2. 5 m, the cumulative settlement of Renqiu City has exceeded 1. 5 m. The ground subsidence brings a series of serious consequences, mainly as follows: The longitudinal slope of the river is slowed down and the flooding capacity is reduced; the longitudinal curve of the railway passenger dedicated line (high-speed rail) is seriously deformed, which affects passenger safety; the national surveying and mapping level is invalid, and the topographic map is distorted, resulting in The planning, construction and management of railways, highways, water conservancy, towns and other infrastructures are chaotic. The national surveying and mapping standards need to be regularly tested, which not only increases the investment, but also causes confusion and brings more losses. The ground subsidence is often accompanied by ground fissures, making urban and rural areas The destruction of facilities such as houses and river embankments will affect the safety of use.

2.5 Brackish Water Interface Moves Down, Seawater Intrusion

Hebei Province mainly has a downward shift of the brackish water interface, which means that the bottom boundary of the saline water in the upper part of the northeastern plain of the Hebei Plain moves downward, posing a threat to the deep fresh water buried in the lower part. According to the relevant information, the brackish water interface between the two typical areas of Luan County and

Lucheng County of Hengshui City has moved down more than 10 m, and the maximum downward movement depth exceeds 30 m. In some areas, the deep freshwater body is changed from salty to salty, which makes the wells scrapped. Seawater intrusion occurred in the coastal rocky and sandy coastal areas along the eastern coast of eastern Yunnan.

2.6 The Spring Water in the Western Plains of the Mountains

The attenuation of groundwater resources is one of the common hazards of over-harvesting groundwater, and the impact is large, resulting in water supply resources not meeting actual needs, and even serious water shortages. Groundwater is mainly formed by the convergence of water from many different sources, including the collection and infiltration of surface water, rainfall and snowmelt, and domestic water. Because the groundwater is relatively clean, it can be widely used. In the process of groundwater exploitation, if the long-term precipitation in the arid area is small, the amount of groundwater exploitation is greater than the recharge, which will cause serious degradation of groundwater resources. Moreover, the use of groundwater has shown a diversified trend. It has been expanded from the use of basic water such as daily water to industrial water and engineering construction water. Although it has produced obvious economic benefits, due to the huge amount of water, the water resources will be attenuated more seriously. If the water planning adjustment cannot be carried out in time, it will lead to more serious problems.

Historically, there are abundant spring water resources in Hebei Province, especially in the western part of the Taihang Mountain front plain. At that time, Baoding was rich in spring water. Xingtai was known as the “Baiquan”, and the black dragon cave spring, Shijiazhuang’s Weizhou Spring, Bailu Spring, and Wuyuan County’s many springs were also famous. Since the 1980s, major springs have been interrupted. At present, one acre spring, Baiquan and Heilongjiang springs have been shut down all the year round. The water output of Weizhou Spring, Dongfeng Lake Spring and Wuyuan Spring has decreased drastically.

2.7 The Ecological Environment Tends to Dry

The plain river channel is cut off and dried up, and the overall ecological environment tends to dry. The decline of shallow groundwater level has increased the thickness of the aeration zone in the Taihang piedmont plain from 3 to 5 m in the 1960s to the current 10 to 40 m, and the central plain has increased from 2 m in the 1960s to the current 5 ~10 m. The change of the thickness of the aerated zone changes the water circulation path of the “water circulation circle”, blocks the water nourishment of the groundwater capillary action on the surface soil, reduces the evaporation of the diving, causes the soil to dry, the vegetation wither and the environment deteriorates. The decline of the groundwater level also led to the drying of the riverbed. The river channel was cut off and dried up, which aggravated the shrinkage of the lake wetland, which not only further increased the trend of climate drying, but also led to the reduction or even disappearance of some aquatic and waterfront biomes.

2.8 Groundwater Resources Are Seriously Polluted

In addition to causing ground subsidence and attenuation of water resources, over-exploitation of groundwater will also lead to environmental and quality pollution of groundwater resources, causing serious deterioration of the hydrological environment. In recent years, in addition to meeting people's living needs, China's groundwater is widely used in chemical, construction and other industries. These factories carry a large amount of toxic chemical substances in the sewage discharge process. Due to the low monitoring level and weak purification ability, industrial sewage is remitted to groundwater resources, and groundwater pollution is serious. In particular, water pollution caused by the chemical industry has caused long-lasting and even irreparable damage to groundwater resources, directly affecting people's health. Therefore, we must pay close attention to the pollution of groundwater resources and take targeted measures to effectively improve the pollution of groundwater resources.

3. Countermeasures for Over-Exploitation of Groundwater

In the face of the current serious situation of groundwater over-exploitation in Hebei Province, it is necessary to take reasonable and effective countermeasures to effectively protect the groundwater resources and environment. At the same time, in view of the limited management methods of the late-stage groundwater, it is necessary to carry out reasonable and effective control in the early or intermediate stage, and take appropriate preventive measures to make the groundwater supply in a stable and healthy state. At present, the following three countermeasures are often applied to the over-exploitation of groundwater.

3.1 Reasonable Division of Groundwater

The groundwater exploitation should be reasonably divided according to the recharge capacity of the groundwater resources. The watershed classification standard includes the replenishment capacity and the overall applicable area. The installation area includes the forbidden mining area, the limited mining area and the seasonal mining area. Forbidden mining area refers to the groundwater area itself has a small water content, blind mining will lead to severely reduced or even depleted groundwater, destroying the ecological balance, and must be prohibited from mining [9]. The limited mining area refers to the area that limits the exploitation of groundwater resources. When the specified limit is exceeded, the mining is prohibited, and the groundwater is restored to the original state before mining. The most important feature of seasonal mining areas is seasonality. For example, in summer, the groundwater content of the groundwater is sufficient for comprehensive mining. In the dry season, the groundwater storage capacity is rapidly reduced. If continuous mining is carried out, water resources will be attenuated. Limit it.

3.2 Control the Amount of Groundwater Extraction

In the limited mining area, the construction of new self-contained water source wells must be strictly examined and approved, and in line with the planned well layout and depth of drilling, in principle, deep water wells are no longer approved [10]. In the forbidden mining area, no groundwater project will be approved, and the existing wells should be well sealed. It is strictly forbidden to build underground water intake projects in urban residential areas where centralized water supply has been implemented. It is necessary to gradually reduce the urban water intake units and permitted water withdrawals. The use of price masts to encourage the preferential use of surface water and rational use of groundwater, increase the collection standards of groundwater resources fees, limit the amount of groundwater exploitation. Effectively adjust the price leverage to promote the protection of groundwater resources.

3.3 Comprehensive Treatment of Groundwater Pollution

There are many pollution factors in the process of groundwater formation in China, both basic artificial water pollution and industrial water pollution. In particular, before the discharge of chemical wastewater, strict water purification should be carried out according to the requirements of the regulations. However, many enterprises have not yet reached the purification standard, that is, discharge, resulting in serious groundwater pollution. In response to this situation, it is necessary to carry out governance from two aspects: First, the government will increase the monitoring of industrial emissions, ensure that drainage meets emission standards, strengthen the protection of groundwater resources, and strictly control enterprises that pollute groundwater to promote the harmlessness of waste. Control; control the application of pesticides and chemical fertilizers, disable highly toxic pesticides; secondly, raise the awareness of reasonable living water, clarify the importance and necessity of water conservation and clean water, and implement comprehensive and effective treatment of groundwater pollution to make groundwater clean and stable. Healthy state.

3.4 Establish A Reasonable Groundwater Exploitation System

Due to the weak concept of reasonable water use and the dual impact of economic interests, groundwater has been subjected to uncontrolled mining, resulting in a large loss of groundwater resources and serious pollution. In order to effectively reverse this situation, the government must

establish a strict and reasonable groundwater exploitation system to enhance the awareness of reasonable water use. Establish and improve the investigation and evaluation mechanism of groundwater resources and development and utilization, improve the planning system for groundwater development, utilization and protection according to the requirements of economic and social development, ecology and environmental protection, and establish the core control of groundwater, water distribution and water level control as the core With the groundwater resource management system combining hydrogeological unit and administrative regional management, the establishment of the groundwater functional zone protection index system, the establishment of the national groundwater functional zoning system, and the rational arrangement of groundwater development and utilization and protection. Standardize the behavior of water exploitation and raise awareness of the protection of groundwater resources. Establish a clear groundwater exploitation system and strict implementation methods to improve groundwater exploitation level, mining efficiency and purification capacity, and rationally protect groundwater resources.

Water conservancy experts have called for the protection of precious groundwater resources, strengthening the construction of groundwater artificial storage projects, and shifting from surface-based storage to surface and underground joint storage; strengthening groundwater source reserves, from disorderly emergency water supply to orderly emergency Water supply transformation; establishment of groundwater resources protection zone to effectively prevent groundwater pollution; special legislation to protect groundwater resources has been urgently required [11].

4. Conclusion

Comprehensive management of groundwater over-exploitation is a necessary measure to achieve sustainable development. Good water ecology is the foundation of ecological civilization construction. Groundwater is an important part of water ecosystem. Rational development and utilization of groundwater and protection of groundwater environment play an irreplaceable role in improving ecological conditions and optimizing production and living environment. Achieving sustainable inevitable needs is an important way to strengthen the construction of ecological civilization and achieve sustainable development.

Comprehensive management of groundwater over-exploitation is a realistic requirement for ensuring water security in North China. The Beijing-Tianjin-Hebei region is a Haihe River basin with severe water shortage. The water ecological environment is a whole, inseparable and influential. The coordinated development of Beijing-Tianjin-Hebei proposes new requirements for “strengthening the expansion of environmental capacity and ecological space” and curbing the over-exploitation of groundwater in Hebei. The water safety in North China and the coordinated development of Beijing-Tianjin-Hebei have long-term significance. They are the realistic requirements for promoting the coordinated development of Beijing-Tianjin-Hebei and ensuring water security in North China.

In short, the hydrogeological environmental hazards caused by over-exploitation of groundwater are quite serious. In the development of the new era, people should pay attention to the protection of groundwater environment, clarify the problems existing in the current over-exploitation groundwater, and take measures to actively respond to make the groundwater environment in a relatively stable and healthy state.

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