Study on Groundwater Dynamics in Southwest Mountainous Areas——Taking Qingshan Tunnel in Chongqing as an example

Kaishuai Zeng[1,a], Wenjun He[1,b], Zhang Yu[1,c], Peng Qi[1,d] , Xiwen Wang[1,e]

[1] School of Environment & Civil Engineering, Chengdu University of Technology, Chengdu 610059, China.

[a]503017264@qq.com, [b]1171329530@qq.com, [c]312662513@qq.com, [d]16602802898@qq.com,

[e] 649412982@qq.com

Abstract

Groundwater dynamics studies help us to advise on the development, use and protection of groundwater resources. Based on the comprehensive analysis of the natural geography, geological conditions and hydrogeological conditions of the Qingshan Tunnel in Chongqing, this paper has proved the distribution characteristics and water-rich characteristics of the water-bearing group of loose rock pore water in the tunnel area, and the groundwater. At the same time, based on the annual groundwater dynamic monitoring data in the tunnel area of Qingshan Tunnel, the dynamic variation characteristics of groundwater level are analyzed, and the atmospheric precipitation and artificial exploitation of groundwater are the main factors affecting the groundwater level dynamics in Qingshan Tunnel area. The flow changes of spring water and creek in the area are positively correlated with the fluctuation of water level in Qiangtang and Minjing, and the flow rate or water level duration curve of the observation point is basically consistent with the rainfall duration curve of the same period.

Keywords

Groundwater Dynamics, Tunnel, Water Level, Flow.

1. Introduction

Groundwater dynamics is an indispensable natural process and is integrated with a variety of conditions on the groundwater system. Groundwater dynamics research is a kind of people's access to groundwater information and reasonable analysis. It is an effective way to understand the formation and evolution of groundwater resources and reveal their characteristics. Groundwater dynamics research and prediction of future groundwater dynamics allow us to develop and utilize groundwater resources more rationally, which allows us to understand the hydrogeological conditions of a region in more detail. It has now become an important issue for hydrology and related workers to study groundwater. Content [1-3]. Dynamic observation is the main content of groundwater dynamic research. It contains two important components, namely, groundwater dynamic classification and prediction. Foreign scholars have studied this aspect earlier than China. Hodgson Frank D.I. (1978) proposed the idea of applying multiple linear regression to simulate groundwater response. E. Zalstberg (1982) also applied multiple regression equations to study groundwater dynamic prediction in the former Soviet Union. The establishment of groundwater dynamic prediction model in China is relatively early, and there is a preliminary progress in the early 1980s. Using regression analysis and correlation analysis, time series analysis, system theory and geostatistics, the groundwater dynamic prediction model is established in multiple directions. Practical application.

In the study of groundwater dynamics, the classification of groundwater is particularly important. Groundwater classification can effectively evaluate the recharge, runoff and discharge conditions of the study area, and qualitative analysis of groundwater dynamic observation. Xi'an Institute of Geology has made some useful explorations in the research of groundwater dynamic classification in recent years, which has opened up a broad prospect for the application of fuzzy mathematics and mathematical statistics in groundwater dynamics research.

2. Physical Geography and Engineering Overview

The entrance of Qingshan Tunnel is located about 50m on the northwest side of S303 Line of Provincial Road, Conglin Town, Chongqing City. The exit is close to the entrance of the jungle tunnel. It is located about 300m on the northwest side of Provincial Highway S303 and 8.0km away from the location of Wansheng District. There is no road. It is connected to the provincial highway of S303 and has poor traffic conditions.

The tunnel area belongs to the subtropical warm and humid monsoon climate, with hot and humid monsoons, four seasons distinct, high temperature in summer, severe cold in winter, and rainy season from May to October. 80% of the annual rainfall is in the rainy season, and November is the dry season in November and March. Rare, the annual rainfall is between 1102.6mm and 1560.4mm, and the annual average rainfall is 1225.0mm. The surface water system in the region belongs to the Lancang River system of the Yangtze River. The water system is developed. It is dominated by branches and has feathers. The valleys are mostly "V" valleys of the deep gorge. The slopes are large, the water flow is urgent, and the terraces are not developed. . The surface water in the inlet and outlet sections of the tunnel belongs to the Xiaozi River and the Jungle River, which are tributaries of the Minjiang River.

The Qingshan Tunnel mainly passes through the strata of the Quaternary and Triassic and Permian. From the new to the old, the alluvial deposit (Q_{al+pl}) is about 2m thick loose soil with small pieces of gravel and residual slope. Q_{el+dl}) 2-10m thick earth and stone, Jialingjiang Formation (T_1j) medium-thick layered limestone, dolomitic limestone, Liangshan Formation (P_1l) gray-black shale, mudstone, Qixia Formation (P_1q) medium-thick layer Limestone, Maokou Formation (P_1m) massive limestone. The mountains that pass through the tunnel are ridge-shaped, controlled by geological structures, and extend along the north-south direction, forming an inter-form of hills, ridges and valleys. The hills are the center of the "claw"-shaped ravines that develop around them; The point is located at the top of the hill on the west side of the tunnel section K10+400. The elevation is 718.6m, the general ground elevation is 565.0-700m, and the lowest point is located in the iron fort bay of the tunnel entrance, with an elevation of 565.0m. The tunneling area is located at the intersection of the Sichuan, Guizhou tectonic belt and the Sichuan-Exiang-China fold belt, and is part of the Xinhuaxia geological tectonic system in the Himalayas. The area traverses the west wing of the Xianjiaping anticline, which is a secondary fold in the keelxi large anticline. The anticline is generally reversed eastward, with a larger inclination of 55-67°, from the nucleus to the divergence of the two wings. Gradually slow down.

3. Hydrogeological overview of the tunnel area

3.1 Groundwater type and sizing characteristics

The groundwater types in the tunnel area are mainly composed of bedrock structure (weathered) fissure water, carbonate rock karst water, carbonate rock and clastic rock interbedded karst water.

The groundwater flow flows from the mountain peaks to the middle saddle area. The hydraulic gradient is positively correlated with the terrain level. The groundwater flow direction conforms to the basic law of the flow field. The groundwater recharge sources mainly include atmospheric precipitation, slope water surface runoff recharge, river downward infiltration and recharge to groundwater or Direct lateral replenishment. The groundwater discharge mode is mainly excreted by evaporation and runoff, and the artificial mining is mainly used during the rainy period.

3.2 Water chemistry characteristics

3.2.1 Types of groundwater quality in tunnels

During the excavation of the tunnel, there were 10 groundwaters in the left hole and a groundwater in the right hole. After the collection of water samples, except for the water quality type of station ZK48+255 is SO_4^{2-}, HCO^{3-}, Ca^{2+}•Mg^{2+}•Na^{2+} type water, and the rest are SO_4^{2-}•HCO_3^-—Ca^{2+}•Mg^{2+} and HCO_3^- •SO_4^{2-}— Ca^{2+}•Mg^{2+}, HCO_3^- •SO_4^{2-}—Ca^{2+} and HCO_3^-—Ca^{2+} type water. The total dissolved solids of groundwater in most gushing waters is 168~736mg/L, which is fresh water; the total dissolved solids of groundwater in some water inrush areas (yK48+035 and ZK48+111) is 2015~2255mg/L, which is brackish water. Groundwater has a pH of 7.16 to 8.55 and is a weak alkaline water.

3.2.2 Water quality standards and evaluation of aggressive CO_2

The groundwater quality of the groundwater at the top of the tunnel is 0.48~232.95mg/L, both of which are <500mg/L standard value, no crystal corrosion; PH value is 7.4~8.39, both >6.5 standard value, no acid corrosion; erosive CO_2 is 0~5.29mg/L, average ∠15mg/L standard value, no carbonate corrosion; HCO_3^- is 90.91~319.50mg/L, both >1.0mg/L standard value, no micro-mineralized corrosion; Mg^{2+}+NH^+ The content is 9.15~50.46mg/L, both <2000mg/L standard value, CL^-+SO_4^{2-}+NO_3^- content is 4.59~241.49mg/L, both <5000mg/L standard value, no crystal decomposition composite corrosion.

There are only two places in the tunnel (ZK48+111 and yK48+035). The groundwater quality SO_4^{2-}ion content is 1272.8~1476.92mg/L, both exceeding the standard value of <500mg/L, which is weak crystal corrosion, SO_4^{2-} of groundwater in other areas. The ion content is 6.02~28.61mg/L, both of which are <500mg/L standard value, which is no crystal corrosion; the PH value is 7.16~8.55, which meets the standard value of 6.5, no acid corrosion; the erosive CO_2 is 0~13.32, <15mg/L standard value, no carbonate type corrosion; HCO_3^- is 156.61~220.21mg/L, >1.0mg/L standard value, no micro-mineralized corrosion; Mg^{2+}+NH^+ content is 2.38~48.94mg/L, <2000mg/L standard value, Cl^-+SO_4^{2-}+NO_3^- content is 12.93~1481.55mg/L, <5000mg/L standard value, no crystal decomposition composite corrosion.

4. Characteristics of rainfall and groundwater dynamics

4.1 Dynamic variation of rainfall and long-term monitoring point flow (water level)

There are 9 monitoring points in the tunnel area, including 1 Qiangtang, 3 streams, 3 wells and 2 spring spots. According to the collected rainfall dynamics (see Figure 4-1), the monthly rainfall is concentrated in the second and third quarters, and the monthly rainfall is less concentrated in the first and fourth quarters. The rainfall is large and small, and the flow of spring water and creek with perennial water flow (or water level) is large and small, and the high and low changes of water level in Qiangtang and Minjing are closely related, that is, the rainfall is large, the flow of spring water and creek On the other hand, the water level in Qiangtang and Minjing is high; on the contrary, the flow of spring water and creek is small, and the water level in Qiangtang and Minjing is low. The amount of rainfall is basically consistent with the change of flow or water level curve of each long-term monitoring point of the tunnel.

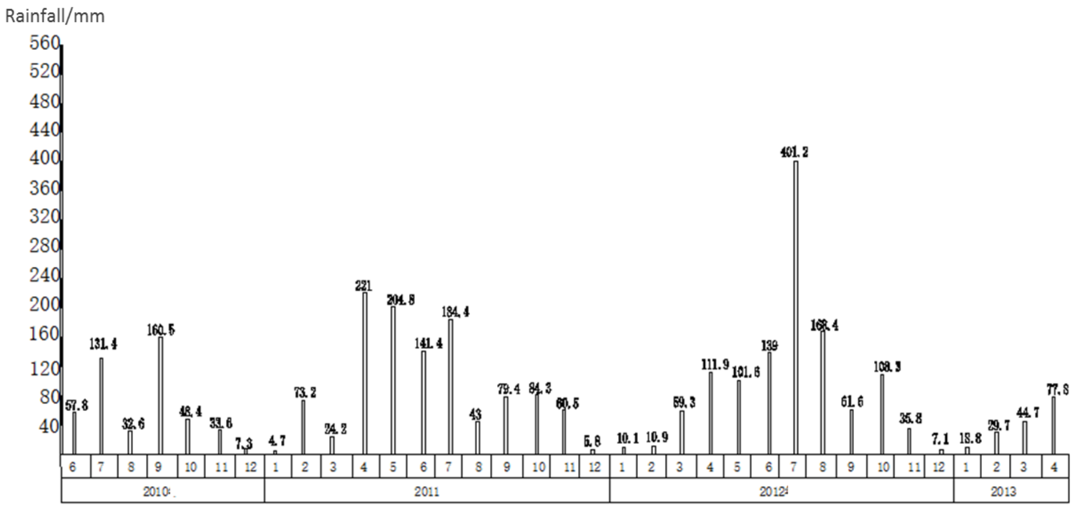

Figure 4-1 Rainfall map for 2010-2013

4.1.1 Dynamic change law of monitoring points in Qiangtang

The monitoring of the Qiangtang monitoring site from January 2012 to December 2012 is based on the monthly maximum water level, monthly minimum water level, monthly average water level, and monthly variation.

Table 4-1 Dynamic monitoring table of water level in Qiangtang

Monthly highest water level (m)	Monthly minimum water level (m)	Monthly average water level (m)	Range of change	Trend
0.45	0.51	0.48	-0.06	decline
0.51	0.57	0.54	-0.06	decline
0.49	0.51	0.64	-0.02	rise
0.31	0.61	0.61	-0.3	rise
0.16	0.34	0.61	-0.18	rise
0.11	0.14	0.61	-0.03	No change
0.09	0.15	0.61	-0.06	rise
0.11	0.14	0.61	-0.03	rise
0.07	0.13	0.61	-0.06	rise
0.05	0.08	0.06	-0.03	rise
0.05	0.12	0.61	-0.07	decline
0.11	0.15	0.61	-0.04	No change

It can be seen from Table 4-1 that the change of water level in Qiangtang changes with the change of seasonal rainfall, that is, the rainfall in the flood season is high, the water level in the pond is high, and the rainfall in the flat and dry seasons is small. It is low. At the same time, the high and low water levels in Qiangtang are closely related to rainfall, and also related to the amount of water released by local farmers when they are irrigated. The water level duration curve of the Qiangtang is basically consistent with the rainfall duration curve of the same period.

4.1.2 Dynamic change law of monitoring points in Xigou

During the hydrological year monitoring work of Xigou monitoring point (from January 2012 to December 2012), the monthly maximum flow, monthly minimum flow, monthly average flow, and monthly variation are shown in Table 4-2:

Table 4-2 Xigou dynamic monitoring table

Time (year. month)	Monitoring point project	Xigou 1	Xigou 2	Xigou 3	Monthly rainfall (mm)
1	Maximum flow rate (L/S)	1.32	0.52	0.00	34.7
	Minimum flow (L/S)	0.12	0.12	0.00	
2	Maximum flow rate (L/S)	0.42	0.26	0.00	14.6
	Minimum flow (L/S)	0.18	0.18	0.00	
3	Maximum flow rate (L/S)	2.19	0.95	0.00	46.2
	Minimum flow (L/S)	0.18	0.12	0.00	
4	Maximum flow rate (L/S)	5.98	1.32	1.42	135
	Minimum flow (L/S)	0.42	0.18	0	

5	Maximum flow rate (L/S)	8.78	6.42	4.64	141.4
	Minimum flow (L/S)	2.85	1.32	1.42	
6	Maximum flow rate (L/S)	11.38	9.28	6.24	208
	Minimum flow (L/S)	6.87	4.71	3.79	
7	Maximum flow rate (L/S)	8.78	6.87	4.9	114.4
	Minimum flow (L/S)	7.34	4.71	4.14	
8	Maximum flow rate (L/S)	7.34	5.98	4.39	87.3
	Minimum flow (L/S)	5.76	4.71	3.66	
9	Maximum flow rate (L/S)	7.77	8.29	4.77	99.4
	Minimum flow (L/S)	5.98	6.2	3.79	
10	Maximum flow rate (L/S)	10.05	10.58	5.55	184.3
	Minimum flow (L/S)	8.05	8.78	4.9	
11	Maximum flow rate (L/S)	9.54	8.78	4.9	126.7
	Minimum flow (L/S)	8.05	8.05	4.39	
12	Maximum flow rate (L/S)	8.05	8.05	4.27	75
	Minimum flow (L/S)	5.98	6.42	2.99	

It can be seen from Table 4-2 that the annual rainfall of the creek flow varies, and is affected by the season. The trajectory duration curve of the creek is basically consistent with the diachronic curve of the same period.

4.1.3 Dynamic variation of monitoring points at the left and right openings of the inlet (outlet) end of the tunnel

The left and right opening monitoring points at the entrance and exit of the tunnel have not had groundwater flow during the monitoring period from January 2012 to December 2012. The entrance section of the tunnel belongs to the reverse slope. During the construction period, although the depth of the right tunnel is several hundred meters longer than that of the left hole, there is no flow in most sections of the right tunnel. Only yk43+050-080 has a large rain or heavy rain. After the heavy rain or heavy rain in the left hole, the main gushing point stations are zk43+090～125 and zk42+785～800, and the flow rate increases with the rainfall intensity, especially after the heavy rain on July 4, 2010. The maximum water inflow in the left tunnel is 931.40L/S (80473m^3/d), which indicates that the groundwater in the inlet section of the tunnel mainly comes from the far limestone distribution area on the south side of the tunnel. The change of the flow at the entrance varies with the seasonal rainfall. The curve is basically consistent with the rainfall duration curve. The exit section of the tunnel belongs to the forward slope. Since the flow of the right opening of Table 4-3 has been connected with the ventilated inclined shaft at the station number yk46+505 on February 16, 2010, the flow rate increases with the rainfall intensity (37.79～339.15L/S).), and the flow rate is always greater than the flow rate of the left hole, indicating that the groundwater in the limestone of the Jialingjiang Formation in the exit section of the tunnel mainly comes from the far side of the tunnel.

4.1.4 Groundwater exposure in tunnels

According to the monitoring data, the tunnel entrance section has entered the third section (T_1j^3) and the first section (T_1j^1) limestone of the Lower Triassic Jialingjiang Formation during the excavation process, while the tunnel exit section passes through the Badong Formation and the Jialingjiang Formation. In the limestone, in the left tunnel station ZK42+795, ZK43+114, ZK46+545, ZK47+870, ZK48+111, ZK48+205, ZK48+255, ZK48+954, ZK49+325-330 and right Groundwater germination occurs in the cave piles yK46+505 and yK48+035. Except for the gushing point at ZK42+795 and ZK47+870, there is no flow during the dry season, and the initial flow of the other gushing points during the dry season is small (see Table 4-3).), the flow is decreasing slowly with time. During the rainy season, the flow rate of the gushing points increases with the intensity of the rainfall.

Table 4-3 Statistical Table of Groundwater Exploitation in Qingshan Tunnel

Monitoring point number	Gushing point Tunnel mileage	Gushing time	Initial flow rate (L/S)	Gushing water formation
Into the left 1	ZK42+795	There is no flow during the dry season, and the flow rate increases with the rainfall intensity during the rainy season.	0	T_{1j}^3
Into the left 2	ZK43+114	April 7, 2010	2.40	T_{1j}^2
Into the right 1	yK43+050	March 15, 2012	0.20	
Left 1	ZK49+330	June 21, 2012	3.059	T_{2b}^2
Left 2	ZK49+325	June 21, 2010	0.14	T_{2b}^2
Left 3	ZK48+954	October 7, 2012	1.461	T_{2b}^2
Left 4	ZK48+255	March 15, 2011	1.35	T_{2b}^2
Left 5	ZK48+205	March 23, 2011	4.026	T_{2b}^2
Left 6	ZK48+111	April 11, 2012	14.455	T_{2b}^1
Right 1	yK48+035	June 10, 2011	2.10	T_{1j}^4
Left 7	ZK47+870	July 30, 2010	132.56(after heavy rain)	T_{2b}^1
Left 8	ZK46+545	December 31, 2011	0.61	T_{1j}^2
Right 2	yK46+505	February 23, 2010	5.05	T_{1j}^1

4.1.5 Dynamic change law of monitoring points in wells

During the monitoring work period of the Minjing monitoring site from January 2012 to December 2012, the monthly maximum water level, the monthly minimum water level, the monthly average water level, and the monthly variation range are shown in Table 4-4.

Table 4-4 Dynamic monitoring table of well water level

Time (year. month)	Monitoring point item	Well 1	Well 2	Well 3	Monthly rainfall (mm)
1	Highest water level (m)	0.36	0.28	0.17	34.7
	Minimum water level (m)	0.45	0.98	0.97	
2	Highest water level (m)	0.38	0.31	0.89	14.6
	Minimum water level (m)	0.43	0.97	1.15	

3	Highest water level (m)	0.33	0.31	0.76	46.2
	Minimum water level (m)	0.47	0.45	0.00	
4	Highest water level (m)	0.19	0.21	0.41	135
	Minimum water level (m)	0.33	0.32	0.78	
5	Highest water level (m)	0.11	0.16	0.21	141.4
	Minimum water level (m)	0.33	0.31	0.4	
6	Highest water level (m)	0.08	0.13	0.17	208
	Minimum water level (m)	0.16	0.16	0.21	
7	Highest water level (m)	0.09	0.08	0.11	114.4
	Minimum water level (m)	0.16	0.16	0.18	
8	Highest water level (m)	0.13	0.12	0.08	87.3
	Minimum water level (m)	0.17	0.16	0.13	
9	Highest water level (m)	0.07	0.07	0.07	99.4
	Minimum water level (m)	0.14	0.13	0.1	
10	Highest water level (m)	0.05	0.06	0.07	184.3
	Minimum water level (m)	0.09	0.55	0.1	
11	Highest water level (m)	0.03	0.52	0.05	126.7
	Minimum water level (m)	0.35	0.82	0.13	
12	Highest water level (m)	0.32	0.63	0.03	75
	Minimum water level (m)	0.47	0.94	0.14	

It can be seen from Table 4-4 that the well water level changes with the change of seasonal rainfall, that is, the water level rises during the wet season and the water level decreases during the dry season; the well water level does not coincide with the rainfall curve at a certain time, and is taken by the local villagers. To.

4.2 Groundwater level dynamic characteristics

The dynamic characteristics of groundwater include the spatial distribution of groundwater level, the characteristics of changes over time, and the dynamic changes of water quality and quantity. Under the influence of natural conditions (meteorological, geological conditions) and human factors, the status and changes of groundwater are reflected.

Obtain the water depth of the three observation wells in the monitoring area (min, 1, 2, 3), and draw the dynamic curve according to the water depth data and rainfall data, as shown in Figures 4-2, 4-3, and 4-4.

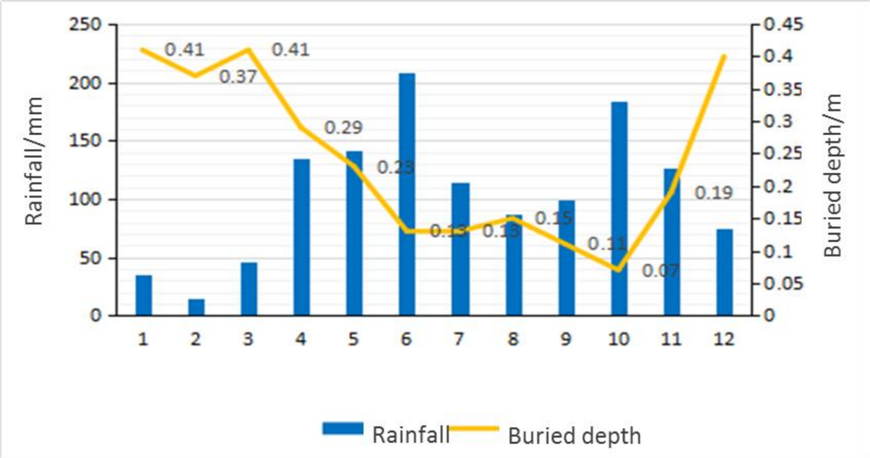

Figure 4-2 Dynamic curve of the water level of the well 1

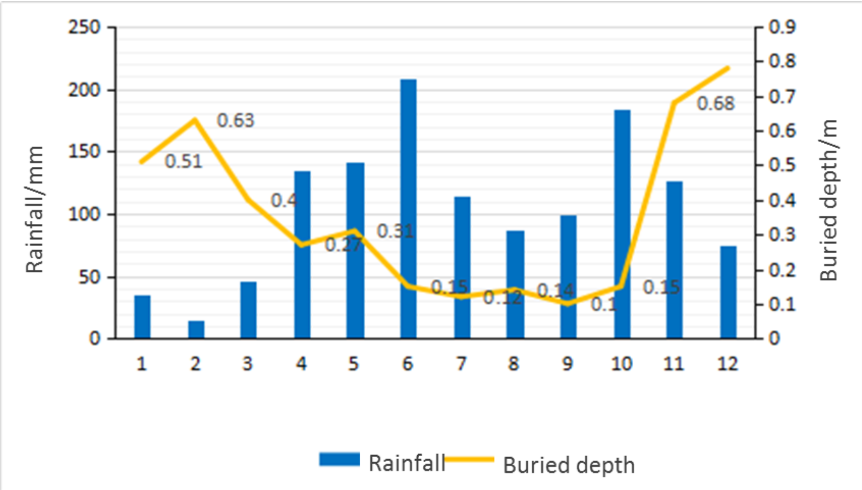

Figure 4-3 Dynamic curve of the water level of the well 2

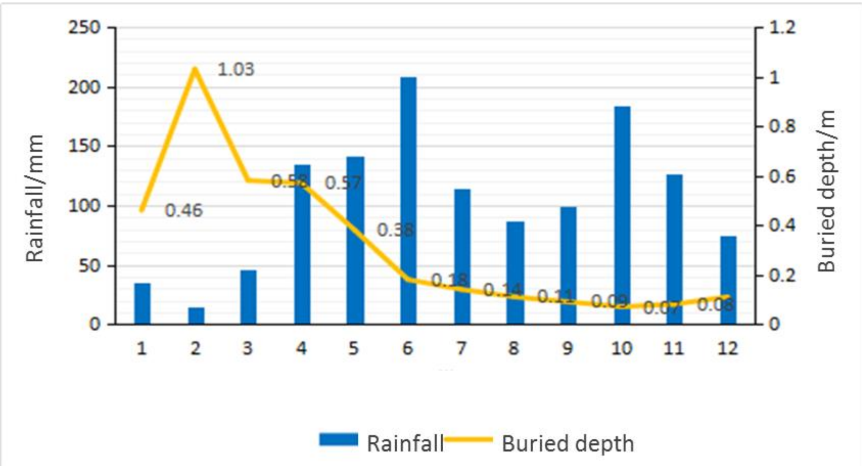

Figure 4-4 Dynamic curve of the water level of the 3 wells

The maximum depth of groundwater level is in February or March. It can be seen from Figure 4-2—4-4 that there is little rainfall in the first quarter, resulting in low water level. The large amount of rainfall in October and the depth of the burial were the impact of human activities at this time. The groundwater level in this area is synchronous with the rainfall. The depth of the well water is inversely proportional to the rainfall, that is, the greater the rainfall, the smaller the buried depth of the well water. The two are closely related. In the dry season, the well water is buried deep, the water period is small, and the two are closely changed. The groundwater depth in the tunnel area is small and is subject to significant changes in rainfall, which is due to the large permeability coefficient in the area.

4.3 Dynamic analysis of ion in groundwater

Most of the groundwater quality types at the top of the tunnel are HCO_3^-—Ca^{2+} and HCO_3^-—Ca^{2+}•Mg^{2+} water, and some are HCO_3^-•SO_4^{2-}—Ca^{2+}•Mg^{2+} or SO_4^{2-}•HCO_3^-—Ca^{2+}•Mg^{2+} type water. The total solid solubility is 125.00~555.00mg/L, which is fresh water. The pH value is mostly 7.4~8.11, which is weak alkaline water.

During the excavation of the tunnel, there were 10 groundwaters in the left hole and a groundwater in the right hole. After the collection of water samples, except for the water quality type of station ZK48+255 is SO_4^{2-}, HCO_3^-, Ca^{2+}•Mg^{2+}•Na^+ type water, and the rest are SO_4^{2-}•HCO_3^-—Ca^{2+}•Mg^{2+} and HCO_3^- •SO_4^{2-}— Ca^{2+}•Mg^{2+}, HCO_3^- •SO_4^{2-}—Ca^{2+} and HCO_3^-—Ca^{2+} type water. The total dissolved solids of groundwater in most gushing waters is 168~736mg/L, which is fresh water; the total dissolved solids of groundwater in some water inrush areas (yK48+035 and ZK48+111) is 2015~2255mg/L, which is brackish water. Groundwater has a pH of 7.16 to 8.55 and is a weak alkaline water.

The groundwater quality of the top groundwater is 0.48~232.95mg/L, both of which are <500mg/L standard value, no crystal corrosion; PH value is 7.4~8.39, both >6.5 standard value, no acid corrosion; aggressive CO_2 0~5.29mg/L, both ∠15mg/L standard value, no carbonate corrosion; HCO_3^- is 90.91~319.50mg/L, both >1.0mg/L standard value, no micro-mineralized corrosion; Mg^{2+} The NH^+ content is 9.15~50.46mg/L, both of which are <2000mg/L standard value, CL^-+SO_4^{2-}+NO_3^- content is 4.59~241.49mg/L, both <5000mg/L standard value, no crystal decomposition composite corrosion.

There are only two places in the tunnel (ZK48+111 and yK48+035). The groundwater quality SO_4^{2-}ion content is 1272.8~1476.92mg/L, both exceeding the standard value of <500mg/L, which is weak crystal corrosion, SO_4^{2-} of groundwater in other areas. The ion content is 6.02~28.61mg/L, both of which are <500mg/L standard value, which is no crystal corrosion; the PH value is 7.16~8.55, which meets the standard value of 6.5, no acid corrosion; the erosive CO_2 is 0~13.32, <15mg/L standard value, no carbonate type corrosion; HCO_3^- is 156.61~220.21mg/L, >1.0mg/L standard value, no micro-mineralized corrosion; Mg^{2+}+NH^+ content is 2.38~48.94mg/L, <2000mg/L standard value, CL^-+SO_4^{2-}+NO_3^- content is 12.93~1481.55mg/L, <5000mg/L standard value, no crystal decomposition composite corrosion.

The water quality monitoring data of this monitoring is lacking and the data is incomplete. The representative well 1 is analyzed for water quality. The soluble solid content, the total hardness of the water and the interannual dynamics of the seven main ions were analyzed. The main ion dynamic curves of groundwater in the dry and abundance periods are plotted 4-5 and 4-6.

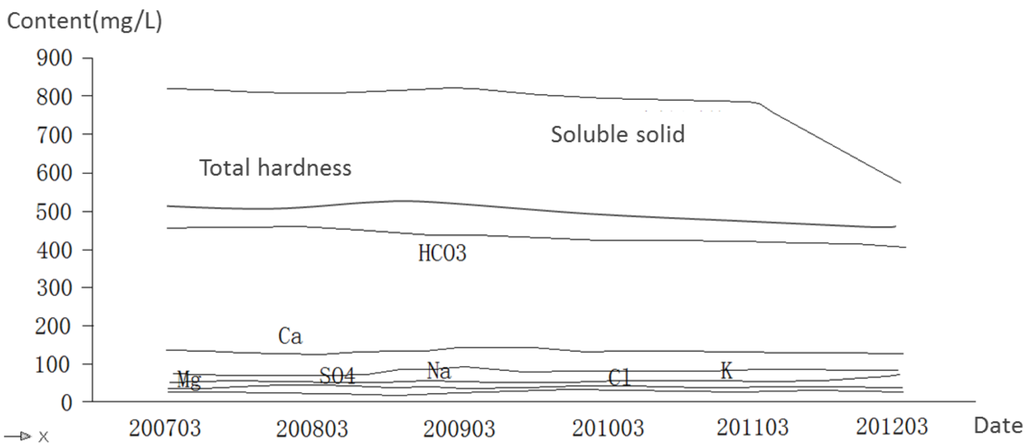

Figure 4-5 Main ion dynamic curve of groundwater in dry season

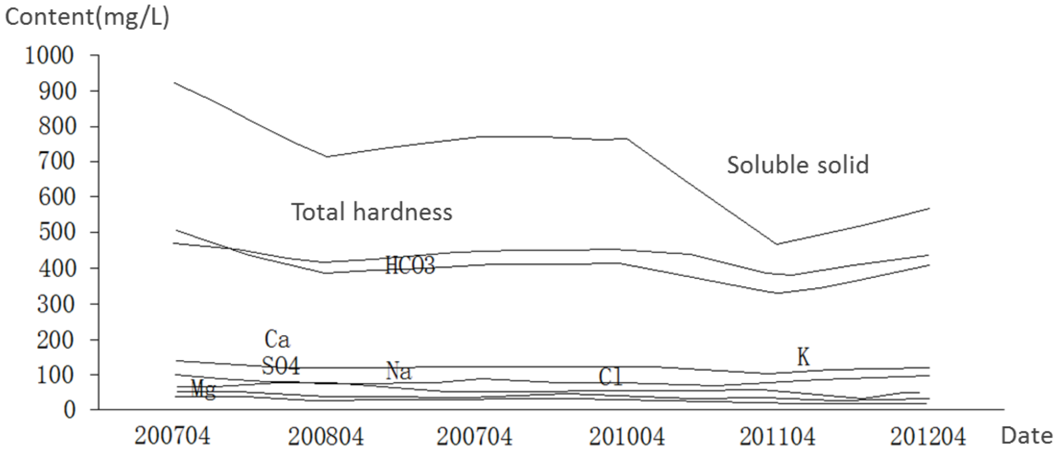

Figure 4-6 Main ion dynamic curve of groundwater in the abundance period

It can be seen from Fig. 4-5 and Fig. 4-6 that only the HCO_3^-component of the seven main examples of groundwater changes, and the other six ions do not change significantly with the seasons. The content of soluble solids is more obvious with the seasons. In general, the ion concentration in the dry season is greater than that in the wet season.

5. Conclusion

This paper collects the relevant data of the Qingshan tunnel site, studies the groundwater dynamics in the area, and analyzes the dynamic changes of groundwater. The main conclusions are as follows:

(1) The groundwater in this area is mostly soil pore water and strong weathered bedrock fissure water. The recharge method is precipitation and surface water. The pore water in the soil layer is discharged along the surface of the bedrock and the fissures to the low crotch. The groundwater type can be divided into Quaternary loose pore water, bedrock fissure water and karst water.

(2) According to the monitoring data of the monitoring points and the rainfall data of the same period, the changes of spring water and creek flow with certain water flow in the monitoring area and the rise and fall of the water level of Qiangtang and Minjing are mainly affected by rainfall and rainfall. The duration of the process is closely related to the size of the rainfall. If the rainfall is large, the flow of spring water and stream will be large, and the water level of the pond and the well will rise. Conversely, the flow will decrease and the water level will decrease, and the flow or water level of the observation point will be observed. The diachronic curve is basically consistent with the rainfall duration curve.

(3) The simple analysis of groundwater samples in tunnel tunnels and the results of aggressive CO_2 analysis show that most of the stranded groundwater exposed in tunnel tunnels is not corrosive to concrete, and there are only two strands of groundwater (station number ZK48 respectively) The SO_4^{2-}ion content of +111 and yK48+035) is 1272.8~1476.92mg/L, both exceeding the standard value of <500mg/L, and there is weak crystal corrosion on concrete.

(4) The flow observation data of each spring point indicates that the groundwater of the spring point in the long-angle area of the tunnel ground belongs to the shallow karst fissure water and the bedrock structure (weathered) fissure water, and the turbulent channel of the groundwater (karst fissure and structure) (Weathering) Fissures) The depth of development is above the elevation of the tunnel roof. During the rainy season, the flow dynamics vary greatly. The limestone widely exposed in the front edge of the inlet is the recharge area of the groundwater.

References

[1] Pie Yanqing. Current Status and Prospects of Groundwater Dynamics Research [J], Journal of Xi'an Institute of Geology, 1996.14(4): 59-65.

[2] Zhao Jinfeng. Influence of water inrush on the surrounding groundwater system and environmental effects [G]. Chengdu University of Technology, 2004.

[3]SUN Jinyu.ZHANG Qiang.XU Mo.Analysis of Groundwater Dynamic Characteristics after Water Gushing in Tunnel Construction[J].Journal of Engineering Geology,2002.629(4):630-634.

[4] Zhao Quan-sheng Feng Juan Guo Xin Xu Ying Zhang Jian-wei. Cutoff Wall Construction Effect of Groundwater Dynamic in the Lower Area of Dagu River [J]. Soil Sci.Soc. Am.J.1992,56:1004 -1015.

[5] LUAN Zhaoqing, LIU Guihua, YAN Baixing Application of Time-Series Model to Predict Groundwater Dynamic in Sanjiang Plain, Northeast China[J] Wetland Science.2011.9(1):48-53.

[6] Fan Jianming. Study on Groundwater Dynamics in the 20 Years of Datong City[J].Groundwater, 2003.52(10):4-5.

[7] Yong Yang Guo-Min Li Yan-Hui Dong. Influence of South to North Water Transfer on groundwater dynamic in Beijing plain[J].Environ Earth Sci . 2012, 65(2): 1323-1331.

[8]Zhou Qing. Study on Dynamic Change Law and Protection Measures of Shallow Groundwater in Heze City[J].Zhihua. 2016. :65-66.

[9] CHEN Beibei GONG Huili LI Xiaojuan LEI Kunchao ZHANG Youquan LI JiweiGU Zhaoqin DANG Yanan, Spatial-temporal Characteristics of Land Subsidence Corresponding to Dynamic Groundwater Funnel in Beijing Municipality, China [J].Chin. Geogra. Sci. 2011 21(6 753–764 .