Study on the Law of the Electric Folding Water Coefficient in Chayuo Middle Banner

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Abstract: In this paper, based on the investigation and research of groundwater types, topography and geomorphology, geological structure, stratigraphic lithology, groundwater richness and agricultural irrigation wells in the area of Chayou Middle Banner Inner Mongolia, a test area is selected and typical wells are determined. The estimating water consumption of typical wells was measured. Based on the calculation results, the distribution map of the Electricity-to-water conversion factor was drawn, and the influence of groundwater type on the Electricity-to-water conversion factor was analyzed. The results show that the type of groundwater has a significant impact on the number of electric water conversion factors, and the electric water conversion coefficients of fracture pore pressure water and groundwater in Neoproterozoic clastic rocks are relatively large; The electric water conversion coefficient of pore and fissure water pressure and groundwater in Neoproterozoic basalt ranks second; Quaternary loose rock pore water average; The bedrock fissure water is the smallest. At the same time, the influence of topography, atmospheric precipitation, and agricultural production on the Electricity-to-water conversion factor under the same type of groundwater was preliminarily investigated.

Keywords: Electricity-to-water Conversion Factor; Influence Factor; Type of Groundwater

Agricultural irrigation water has always been the main component of social water use, most areas of agricultural irrigation water use more than 70 per cent of the total water use, especially in the arid and semi-arid regions of western China, this phenomenon is more obvious [1]. How to fundamentally solve this problem, we need to reform the agricultural water rights and water prices in the region according to local conditions. Therefore, a rapid and accurate grasp of the relevant areas of agricultural irrigation water use, has become the relevant departments to regulate the irrigation behaviour of farmers, the development of relevant policies of the primary problem. In recent years, the statistical method of "discounting water with electricity" has been widely used in water abstraction assessment and water resource management. The "electricity discount" is a method of analysing the water and electricity conversion coefficients by studying the relationship between electricity consumption and the amount of water withdrawn, and then deducing the amount of water withdrawn by calculating the product of the electricity consumption and the water and electricity conversion coefficients. The amount of water used for agricultural irrigation obtained by using the "electricity discount" not only counts the total amount of water used for agricultural irrigation, but also excludes the return water reused for irrigation, making it a more accurate method of measuring modern agricultural water consumption.

Studies and regional practices have demonstrated that agricultural water rights, water pricing reforms and other measures can reduce the total amount of irrigation water used by increasing the cost of water use, which has become an important way to regulate farmers' irrigation behaviours [2-3], and that reliable water metering is a prerequisite for the implementation of agricultural water rights, water pricing, water resource tax reforms, and other initiatives for precise water resource management [4]. Although some regions in China have piloted direct metering of irrigation water using mechanical, ultrasonic, and smart card meters, and have gained some experience [5-6], direct metering of irrigation water is still difficult to implement in most regions due to backward technology, economics, and other realities. Starting from the 1970s, the electricity discount method, which uses the electricity consumption of water pumps as an indicator to indirectly estimate the amount of groundwater extraction, has been gradually established [7-8], and has been used in the fields of water abstraction assessment and water resource management [9-11]. In recent years, with the increasing maturity of the "electricity discount" technology, many large agricultural provinces in China have adopted the "electricity discount" as the main method for calculating agricultural irrigation water use. Determining the coefficient of water discounted by electricity is a prerequisite for water discounting programmes, and since this coefficient is affected by a variety of factors, more and more scholars are focusing on the study of the factors affecting the coefficient of "water discounted by electricity". Li Fei [12]and other research on the impact of Hebei Plain Agricultural Irrigation Electricity Discounting Coefficient analysed the impact of relevant regional characteristics and seasonal changes in groundwater on the electricity discounting coefficient in the region. Chen Weiguo [13]analysed the correlation between the efficiency of the pumping unit and the number of water discounting systems by electricity to infer the accuracy of the actual number of water discounting systems by electricity. Fan Hongmei et al [14]analysed the number of electricity discounted water coefficients by different models based on the data collected from Inner Mongolia horqin district, so as to obtain the best prediction accuracy of BP neural network model. Wang Jianyong, Yue Shiru and other [15-17]scholars also found that the number of water discounting system by electricity is affected by the nature of the aquifer, groundwater depth changes, pumping efficiency and the type of irrigation technology.

Chayuzhong Banner Agricultural Irrigation Area in Inner Mongolia is a typical semi-arid irrigation area in the western part of the country, which has a variety of aquifer structures with different types of undulations, and the distribution of the number of electrically discounted water systems is relatively obvious. Therefore, this study takes the number of water discounted by electricity in the agricultural irrigation area of Chayuzhong Banner in the middle of Inner Mongolia as the research object, and explores the relationship between different groundwater types and the number of water discounted by electricity in the area; it provides data support and theoretical reference for the statistical work of "water discounted by electricity" in the area, as well as the establishment of a new mechanism for the management of the irrigation area in other areas of the western region with similar natural environments, and the introduction of the policy of "water discounted by electricity". Provide data support and theoretical reference.

1. Data and Methods

1.1 Overview of the Study Area

The study area is located in the central part of Ulanchab City, Inner Mongolia, in the territory of Chayuzhong Banner in the northern foothills of Huitengxile, a tributary of the Yinshan Mountains, with a total area of 4,190.2km2 [18]. The northern part is an inland river basin, and a larger Dingji River develops in the Houdaitan Basin, with a watershed area of 1000km2 in the territory [19]. The southwestern part is the Yellow River Basin, with two tributaries of the Yellow Flag Sea system in Datan Township and Ulansum, with a watershed area of 889.45 km2 in the flag.In addition, there are some seasonal flood discharge gullies and catchment lakes in the flag. The lakes are mostly distributed on basalt terraces and are recharged by groundwater, of which about 30 lakes collect water all year round [20]. The area of arable land in the territory is 1,429,600 mu. There are 4758 electromechanical wells for farmland irrigation, controlling 563,900 mu of irrigated area, including 486,600 mu of drip irrigation, 77,000 mu of sprinkler irrigation, and 0.03 million mu of tube irrigation [19]. According to the data of the water resources bulletin of Chayuzhong Banner, the total groundwater water consumption of the whole banner was 59.36 million m3 in 2018, of which the agricultural irrigation water consumption accounted for 89.63% of the total groundwater water consumption [21], which is one of the main causes of groundwater over-exploitation in the region, and is also a key target of the comprehensive groundwater over-exploitation management. Only 168 sets of flow meters were installed in agricultural irrigation wells in the territory at the beginning of 2020, but the wireless telemetry module and monitoring terminal equipment are not sound, and the data of the equipment are not accessible for the time being, so it is not possible to accurately obtain the water consumption.

1.2 Research Methodology

1.2.1 Delineation of the Electricity as A Fraction of Water (EFW) Test Area

The overall idea of measuring the number of water systems by electricity is "to project all by typical". The study area is divided into six test zones: Neoproterozoic clastic rock type fissure pore pressure water I zone, Neoproterozoic basalt hole fissure pressure water II zone, Quaternary loose rock type pore dive III zone, Neoproterozoic clastic rock type fissure pore dive IV zone, Neoproterozoic basalt hole fissure dive V zone, and bedrock fissure water zone VI zone. The test area was divided into several test zones in order from high to low in reference to the water richness grade.

The "Zonal Water-Richness Classification Criteria" classifies the water-richness of different groundwater types into seven classes: extremely abundant water (>5000m3/d from a single well), very abundant water (3000-5000m3/d from a single well), abundant water (2000-3000m3/d from a single well), rich water (1000-2000m3/d from a single well), moderate water (500-1000m3/d from a single well influx), medium water (100-500m3/d from a single well influx), and poor water (<100m3/d from a single well influx) [22].

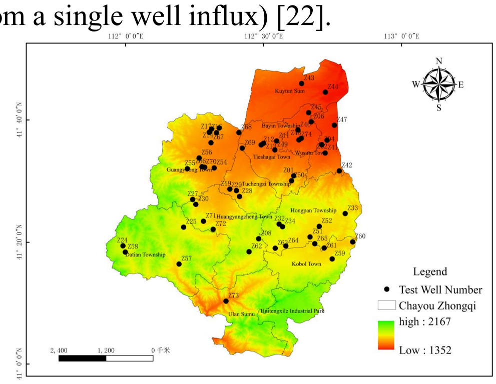

Figure 1. Typical Well Location Map

1.2.2 Typical Well Selection

On the basis of the survey in each test area, typical wells were selected on the basis of the depth of the water table, the type of pumps that accounted for a larger proportion, the type of irrigation, and the number of electromechanical wells. In addition, the selection of typical wells also takes into account the differences in the arrangement of electromechanical wells, irrigation types and pump models of electromechanical wells in each township. There are 4758 electromechanical wells in 12 townships in the study area, and according to the above selection principles and considering the number of samples and representativeness, one typical well is set up for every 50 to 100 irrigation electromechanical wells. A total of 56 typical wells were selected, including 49 for drip irrigation, 5 for sprinkler irrigation, and 2 for tube irrigation.

1.2.3 Typical Wells Measured in Terms of Electric Discounted Water Coefficients

The data for the calculation of the "electricity to water" factor are measured on-site, mainly in terms of electricity consumption and water output from agricultural irrigation machines and wells. Power consumption is measured using local electricity meters, and water output is measured using portable ultrasonic flow meters and mechanical water meters. Water output measurement time according to the pump is turned on, 1h after the water flow stabilisation measurement. Measurement time is not less than 1h, every 10min read a number of times, and meter readings and water meter readings synchronised. Mechanical water meter by water flow to promote the meter rotation, affected by friction. Portable ultrasonic flowmeter is easy to install, no contact with the fluid, than the mechanical water meter accuracy. This water volume test according to different practical situations using the above two methods, mainly portable ultrasonic flowmeter.

Conduct a detailed field survey of typical wells in terms of irrigation methods, irrigation conditions, irrigation systems, farming practices, planting structures, soils, etc., and calculate the number of water equivalent to electricity for typical wells on the basis of on-site measurements of water output per unit of time from electromechanical wells and the simultaneous collection of data from the special transformers and independent electricity meters that accompany electromechanical wells for agricultural irrigation.

Use equation (1) to calculate a typical well's water discount factor in terms of electricity:

$$Tc = \frac{W}{E} = \frac{Qt}{E} = \frac{3600\eta 1 \cdot \eta 2}{gH} \quad (1)$$

Where: Tc - water and electricity conversion coefficient (m3/kWh); W - total water output in t time period (m3); Qt - water lifting flow rate in t time period (m3/h) ; η1- power supply efficiency in t time period, mainly reflecting the degree of voltage stability; η2 - water pump use efficiency in t time period; E - power consumption in t time period (kWh); H - water pump head (m); - gravity reflecting the degree of voltage stability; η2- efficiency of water pump use in the t-time period; E - power consumption in the t-time period (kWh); H - water pump head (m); - gravitational acceleration [13].

2. Results and Analyses

2.1 Pilot Areas are Determined by the Number of Electrically Discounted Water Systems

Plotting typical wells on the basis of the results of the calculations for the electricity-to-water coefficient (see table 1).

Table 1. Table of Electricity-to-Water Conversion Factors

test area	machine well site	Test Well No..	Water Pump Model	Measurement of water output (m3/h)	Initial Meter Degree	Meterter mination	Transformer multiple	Measurement of electricity consumption (kWh)	Electricity to water system (m3/kWh)
Pressurised water in fissure pore of Neoproterozoic clastic rocks ZoneI	I1	Z49	200QJ50-104	34.43	4104.96	4106.13	30	35.1	0.98
		Z04	200QJ40-117	33.4	8630	8631	30	30	1.11
	I2	Z02	200QJ40-117	48.11	5961	5962	30	30	1.6
		Z13	200QJ50-104	55.39	2337.84	2338.39	30	49.5	1.12
		Z01	200QJ40-104	55.06	1172.2	1175	10	28	1.97
		Z65	200QJ60-89	42.45	167.05	168.01	20	19.2	2.21
	I3	Z12	200QJ80-120	60.93	2082.45	2082.74	60	23.2	2.63
		Z74	200JJ40-114	41.64	3726.74	3727.81	30	32.1	1.3
		Z24	200QJ32-91	37.07	1083.14	1083.46	30	19.2	1.93
	I4	Z11	200QJ80-120	55.98	733.75	734.23	30	14.4	3.89
		Z55	200QJ50-91	54.84	3085.85	3099.95	0	14.1	3.89
		Z72	200QJ50-90	33.59	1511.36	1511.62	60	15.6	2.15
		Z51	200QJ32-104	47.96	953.52	954.6	20	21.6	2.22
		Z44	200QJ32-104	32.55	564.15	574.17	0	10.02	3.25
		Z69	200QJ20-132	38.19	2090.59	2091.13	30	16.2	2.36
	I5	Z42	200QJ50-117	35.25	2354.7	2355.18	30	14.4	2.45
		Z67	200QJ32-114	53.7	9537.29	9537.84	30	16.5	3.25
		Z45	200QJ32-130	33.1	69459.07	69485.63	0	26.56	1.25
		Z43	200QJ40-91	37.59	1404.54	1405.48	20	18.8	2
	I6	Z06	200QJ20-78	10.42	945.07	945.45	30	11.4	0.91
		Z46	200QJ32-130	34.61	3802.97	3803.6	30	18.9	1.83
		Z09	200QJ32-175	15.4	4211.95	4213.13	50	33.5	0.46
		Z29	200QJ50-91	49.21	1889.48	1889.97	30	14.7	3.35
		Z28	200QJ25-130	25.45	966.89	967.98	30	32.7	0.78
Neoproterozoic basalt pore and fissure pressurised water Zone II	II1	Z27	200QJ50-78	29.85	897.88	898.15	60	16.2	1.84
		Z52	200QJ40-91	38.71	102.45	103.5	20	21	1.84
		Z61	200QJ32-117	39.65	9739.07	9744	5	24.65	1.61
	II2	Z16	200QJ25-268	37.69	13115.25	13115.96	30	21.3	1.76
		Z71	200QJ30-91	42.49	5654.59	5655.31	30	21.6	1.97
		Z47	200QJ20-130	29.63	11371.86	11389.47	0	17.61	1.68
		Z19	200QJ32-117	26.43	7241	7242	30	30	0.88
		Z66	200QJ20-117	10.85	5635.91	5636.89	10	6	1.81
		Z48	200JJ40-114	54.53	413.75	415.31	20	31.2	1.75
Quaterna	III	Z50	200QJ30-158	46.03	10108.77	10109.99	30	36.6	1.26

ry Loose Rock-like Pore Diving Zone III		Z17	200QJ20-224	34.02	13115.96	13116.37	30	18.45	1.84
		Z73	200QJ20-78	33.79	842.56	843.58	30	20.7	1.63
		Z25	200GJ50-97	17.97	573.48	574.46	30	29.4	0.61
		Z15	200QJ25-156	29.3	5296.4	5297.2	10	18.46	1.59
		Z70	200QJ63-96	10.85	5636.29	5636.89	30	18	0.6
		Z68	200QJ20-200	6.13	21850.31	21870.46	0	20.15	0.31
		Z30	200QJ32-105	17.52	2901.1	2902.73	10	16.3	1.07
		Z57	200QJ50-65	2.8	390.05	393.71	10	36.6	0.08
Neoproterozoic clastic rock-like fissure pore diving Zone IV	IV1	Z64	200QJ40-132	16.24	7724.64	7725.35	20	14.2	1.14
		Z60	200QJ50-82	83.53	1748.93	1749.76	60	49.8	1.68
	IV2	Z63	200QJ32-104	41.08	969.81	970.56	30	22.5	1.83
	IV3	Z08	200QJ50-90	60.62	3544.76	3545.95	30	35.7	1.7
		Z33	200QJ32-130	28.78	3520.53	3521.4	30	26.1	1.11
		Z34	200QJ32-104	38.28	3790.36	3791.44	30	21.6	1.77
		Z59	200QJ40-91	40.16	881.85	882.74	30	26.7	1.5
	IV4	Z32	200QJ32-91	33.19	815.09	816.28	20	23.8	1.39
Neoproterozoic basalt hole-fracture diving Zone V	V1	Z41	200QJ30-118	46.46	3045.09	3046.55	30	43.8	1.06
		Z54	200QJ40-104	19.25	23937.5	23957.2	0	19.7	0.98
	V2	Z58	200QJ32-78	29.06	158.92	159.4	60	28.8	1.01
		Z56	200QJ32-114	18.8	5.4	21.69	0	16.29	1.15
		Z14	200QJ20-270	20.48	5831.21	5831.58	30	19.59	1.04
Bedrock Fissure Water VI	VI	Z62	200QJ32-105	5.53	1642.11	1655.61	0	13.5	0.41

Note: In the table, the typical well Z57 has a water factor of 0.08, which is anomalous according to the on-site investigation combined with the pumping test data. The pump model of this point is 200QJ50-65, the hourly power consumption is 36.6 kWh, but the hourly water output is only 2.8m3, and there is black muddy water after half an hour of continuous pumping, so it is judged that the data of this point is incorrect and the point is excluded.

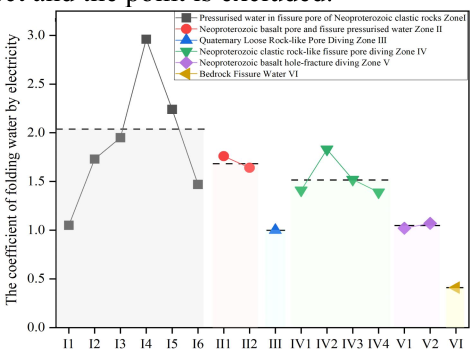

Figure 2. Chart of Electricity-to-water Conversion Factor in the Test Area

The average value of the electrode discounting coefficient of the typical wells in each test plot, and the average value of the electrode discounting coefficient of the test area are the average values of the electrode discounting coefficients of the test plots in the test area. The number of electrically discounted water coefficients in the test area is shown in Figure 2.

2.2 Analysis of the Factors Influencing the Number of Water Discounting Coefficients in Terms of Electricity

As can be seen from Fig. 2, the number of electrodynamic folding coefficients in the pressurised water zone in the study area is generally higher than that in the submerged zone; and the number of electrodynamic folding coefficients in the clastic type zone is higher than that in the basalt type zone and higher than that in the loose rock type zone and higher than that in the bedrock fissure water type zone. That is to say, the number of electro-refractive coefficients of different groundwater types is basically proportional to the water richness of the groundwater type. However, in the case of the same groundwater type, the number of electrodynamic folding coefficients in each test area showed a non-linear correlation with its water richness.

2.2.1 Influence of Groundwater Type on the Number of Electrodynamic Discounted Water Coefficients

(1) Pressurised water in fissure pores of Neoproterozoic clastic rock types

As shown in Table 1 Fig. 2, there are 24 typical wells in the Neoproterozoic clastic rock-like fissure pressurised water I area, which is divided into 6 experimental plots. The range of the electrically discounted water coefficients is 0.46-3.89, and the mean value is 2.04, which has the largest mean value of the electrically discounted water coefficients among all the six study areas. This kind of groundwater is endowed in the pore space of Neoproterozoic clastic rocks and sand gravels, and is spatially staggered up and down, and the water-bearing layer is generally 1-5 layers. According to the topography and geomorphology and the burial characteristics of the Neoproterozoic clastic rock aquifer, it is inferred that the Neoproterozoic clastic rock fissure groundwater system in this area is a semi-closed system. Although there is no transit underground runoff recharge, there are various ways of recharge such as atmospheric precipitation, infiltration of mountain surface flood water, return infiltration of field irrigation water and lateral recharge of bedrock fissure water from neighbouring mountainous areas, which makes this type of groundwater very rich in water content. Therefore, this is the main type of groundwater in the area and is the main purpose layer for groundwater extraction in the area at this stage.

(2) Pressurised water in pore fissures of Neoproterozoic basalt

As shown in Table 1 Fig. 2, there are 9 typical wells in the Neoproterozoic basalt pore fissure pressurised water II area, which are divided into 2 test subareas. The range of the electrical discounted water coefficient is 0.88-1.97, and the average value is 1.68, with some fluctuations. This is due to the fact that the basalt pore fissure water and Neoproterozoic clastic fissure pore water aquifers in the former Daitan Basin groundwater system are mostly staggered up and down in space, and there is a close hydraulic connection between them, so the two are essentially a unified aquifer system, and both have the dual hydraulic properties of submersible and pressurised water, and some of them have been influenced by the Neoproterozoic clastic fissure pore water. Under the influence of Neoproterozoic clastic fracture pore water, the typical wells in the area of pore fissure water have a higher number of electro-refractive water system compared with other test areas. This kind of groundwater is mainly endowed in basalt pore fissures and columnar joint fissures, and in space, it is mostly intersected up and down, and the water-bearing layer is usually 1-3 layers, which is generally rich in water and has a higher electrodynamic folding coefficient.

(3) Quaternary loose rock-like pore diving

From Table 1 Figure 2, we know that there are 9 typical wells in Quaternary Loose Rock Pore Diving Area III, and there is no distinction between the test areas, and after excluding the typical well No. Z57, the remaining typical wells are statistically evaluated in terms of the number of electrodynamic folding coefficients, and the range of the number of electrodynamic folding coefficients is 0.31-1.84, with the average value of 1.00, which is more obvious in terms of the number of fluctuations of the electrodynamic folding coefficients. This is due to the large difference in water richness of the Quaternary loose rock aquifer in the region, in which the water-rich area, the water output of a single well can reach 10002000m3/d (level 1); while the water-poor area has a water output of less than 100m3/d (level 4). The pore water recharge of the loose rock type of the fourth system mainly consists of direct infiltration of atmospheric precipitation and lateral recharge of bedrock fissure water on both sides of the gully, and the sources of groundwater recharge are different in different areas. If the lateral recharge of bedrock fissure water accounts for a large proportion, the amount of water will be abundant, and the number of electric folding water system will be large, and vice versa will be small.

(4) Fissure pore diving in Neoproterozoic clastic rocks

As can be seen from Table 1 and Figure 2, there are 8 typical wells in the Neoproterozoic clastic dive area VI, which are divided into 4 test areas. The range of the electrodynamic factor in the test area is 1.39-1.83, and the average value is 1.53. The electrodynamic factors in the test area VI1-VI4 are 1.41, 1.83, 1.50 and 1.39, and the difference of the electrodynamic factor is relatively small. It shows that the EDFs of these groundwaters are stable and less affected by other factors. This type of groundwater has the same stratigraphic lithology as that of the pressurised water in the fissure pore of the Neocene clastic rocks, and it also has high water richness, and the water output of some single wells can reach up to 3,000-5,000m3/d (Class I). Therefore, this type of groundwater is currently the main purpose layer for groundwater exploitation in Hongpan Township and Kobol Township, and is also one of the most important sources of tap water in Chayuzhongqi area.

(5) Neoproterozoic basalt hole-fracture diving

According to Table 1 Fig. 2, it can be seen that there are 5 typical wells in Neoproterozoic basalt pore fissure diving area V, which are distributed in 2 test subareas. The range of electrodynamic discounted water coefficient is 0.98-1.15, and the average value is 1.05, which makes the electrodynamic discounted water coefficient more stable. The Neoproterozoic basalt pore fissure pressurised water has the same stratigraphic lithology as that of the dive, so the regional water enrichment of these two groundwater types is similar. Therefore, there is a certain similarity between this test area and the distribution pattern of electrodynamic folding coefficients in Zone II of the Neoproterozoic basalt hole pressurised water.

(6) Bedrock fissure water

As can be seen from Table 1Figure 2, there is one typical well in bedrock fissure water Zone VI, with an electric folding water coefficient of 0.45, which is the smallest average value among all six test zones, and is much lower than that of other groundwater type zones. Bedrock fissure water is mainly endowed in bedrock fissures and is mostly submerged. Moreover, the bedrock fissures are mostly permeable to groundwater, water conduction channels, and the thickness of aquifer is thin, generally less than 10 m. Therefore, the water richness of this type of groundwater is weak, and the amount of water is poor, and the number of electric folding water system is small. The samples of electromechanical wells are small and the research value is low, so more typical wells are not selected. The main recharge mode of this groundwater type is infiltration of atmospheric precipitation, which has limited recharge capacity to groundwater, and this is one of the reasons for the small number of electrically discounted water systems in the area.

2.2.2 Other Influencing Factors

(1) Atmospheric precipitation

The region belongs to the arid and semi-arid continental monsoon climate zone in the middle temperate zone, which is mainly represented by a dry and windy spring, a short and cool summer and autumn with a large temperature difference and plenty of sunshine, and a dry, snowy and long cold winter. Due to the vast area of the land, the topography is complex, can be divided into the back of the Daitan mild arid and semi-arid climate zone, the front of the Daitan warm and cool semi-arid climate zone and the southern mountainous temperature and cold semi-arid and humid climate zone, the meteorological characteristics of the obvious north-south strips of the difference in characteristics. The rainy season is short, precipitation is low, from south to north precipitation is decreasing trend, the maximum difference between north and south precipitation is 139.7 mm. the distribution of precipitation within the year is not uniform, precipitation inter-annual variation is large, precipitation is mainly concentrated in the month of 69 months, the four-month precipitation accounted for 67 per cent 78 per cent of the annual precipitation. In addition, due to the arid climate, the average evaporation over the years is 17002900mm, contrary to the precipitation, with an increasing trend from south to north. The evaporation is mainly concentrated in the month of 48, which accounts for about 70% of the annual evaporation [23].

Generally, areas with high precipitation and low evaporation are rich in groundwater, with a high electro-folding water coefficient. However, the average annual precipitation in Huitengxile Park ranges from 350 mm to 430 mm, which is the highest in the study area, and the average annual evaporation is low. But the electrical folding water coefficient is the worst in the study area. It is inferred that this is because of the high topography of the area, poor infiltration and water holding capacity of the rock formations, and the difficulty of effective recharge of groundwater by soil moisture at the end of the precipitation process [24]. This suggests that meteorological factors in this study area have a small influence on the number of electrodynamic folding water systems and cannot play a decisive role.

(2)Topographic and geomorphological factors

The region is located in the Yinshan Mountains, the eastern part of the Daqingshan, the terrain is more undulating, the terrain is generally high in the west and low in the east, high in the south and low in the north. In the south, Daqingshan Mountain and Huitengliang stretch across the east and west, and Huitengliang has a higher topography and flat terrain; in the middle, there is a nearly east-west distribution of the Erdaoba low mountains - hilly area, with an elevation of 15001900m, which divides the area into two mountain basins, the former Datan and the latter

Datan. As can be seen from the distribution map , the overall distribution of the number of electrodynamic folding water system is: gradually decreasing from north to south; starting from Bayin Township and Wusutu Township, a linear area with significantly higher number of electrodynamic folding water system than the surrounding area extends to the southwest; the southern region of Kobul Township and Hongpan Township, where the number of electrodynamic folding water system is also generally higher, are located in the topography of the low topography of flat valleys or beaches. These areas are all in the lower topography of the flat valley or beach. The coincidence of the distribution pattern between the two shows the high correlation between the number of electromechanical wells and the topography: the number of electrically discounted water systems is higher in the relatively flat and low terrain areas, and the number of electrically discounted water systems is lower in the higher terrain areas. And even in high altitude areas with flat topography, the number of EWDs is still poor (Huitengxile Park).(3)Socio-economic factors

Chayuzhong Banner area to electricity folding water system distribution law is also closely related to the development of agriculture in the region; to the north to electricity folding water system number of the highest part of the region as an example: Wusutu town terrain in the south high and low in the north, in addition to the south and the central part of the hilly, the rest of the land is relatively flat, and rich in water, fertile soil, to the development of modern facilities for the development of agriculture has a unique conditions. And its bordering Bayin Township is a speciality vegetable growing area with irrigated agriculture. These areas have benefited from the long-standing development of the planting industry, and the irrigation electromechanical well equipment is more advanced and generally higher in power, which has led to a significantly higher number of electricity-discounted water systems in these areas than in other areas. Hongpan Township and Datan Township in the centre of the country is a combination of agriculture and animal husbandry dry farming and animal husbandry area, so only a small part of the area with a higher number of electricity discount water system. In the south of Huitengxile Park, tourism is the main industry, there is almost no agriculture-related industry, and the number of electromechanical wells is scarce, so the electric folding water coefficient is the worst. It can be seen that the better the water richness of the area, the better the agricultural development, the more complete the mechanical and electrical wells and pumps and other related facilities, the greater the coefficient of water discounted by electricity.

3. Discussions

This paper takes groundwater type as the main object of study and discusses other factors affecting the Electrode Discounting Coefficient (EDC). Generally speaking, the EWD depends on the richness of groundwater in the area, i.e., the EWD is higher in areas with good water richness. This is the same as the conclusion of Yin Shiyang et al. [25], who analysed the factors affecting the coefficient of "discounted water by electricity" in the plain area of Beijing, and concluded that the smaller the depth of groundwater and the better the water richness of the aquifer, the higher the coefficient of "discounted water by electricity" is. In the further analysis of this paper, it is found that the type of aquifer has a greater influence on the amount of groundwater in different areas within the territory of Chayuzhong Banner, which directly determines the number of the electrodynamic discounting coefficient in each area. Therefore, the distribution law of the number of water discount system basically follows the distribution of aquifer types in the area. However, the following problems were found during the investigation; firstly, the aging degree of the electromechanical wells greatly affects the specific value of the EWD, secondly, the degree of agricultural development in Chayuzhong Banner varies, and the co-existence of drip and diffuse irrigation methods has caused a certain degree of interference in the analysis of the EWD, and in fact, most of the reasons for the dramatic fluctuations of the EWD in the experimental area are almost entirely from this. In fact, almost all of the reasons for the sharp fluctuations of the EWF in most of the test areas are from this. Fan Hongmei et al. [14]also mentioned the relevant factors in their study of the coefficient based on various methods: groundwater depth, pump age, and irrigation method all correlate well with the coefficient, and Liang Xueli et al. In the study of "Factors affecting the number of water tariffs" conducted by Liang Xueli et al. [26]in Xingtai City, Hebei

Province, it was also shown that the irrigation method significantly affects the number of water tariffs in an area. However, the fluctuations in the number of EWDs in individual areas caused by these factors are very small in the whole study area. In addition, this paper also found that precipitation and evapotranspiration also have very little influence on the pattern of EDWC in Chayuzhongqi area, and the aquifer systems with atmospheric precipitation as the main or even the only recharge method are generally very poor in water enrichment, and the EDWC in these areas is also low; in addition, many factors such as the characteristics of the pumps of the irrigation wells, the degree of loss of pumps, pump head, and the loss of lines also affect the EDWC to a certain extent. In addition, many factors, such as the characteristics of irrigation well pumps, pump head, line losses, etc., will also affect the coefficient of electricity to some extent.

4. Conclusions

In the study, it was found that groundwater richness is the dominant factor affecting the number of water discounting systems in the area, and when the groundwater types are different, the two show a positive proportional relationship. That is, the better the groundwater richness of the type of groundwater is, the greater the number of water discount system with electricity, and vice versa, the smaller it is. When the groundwater type is the same, due to the topography, agricultural development, precipitation and other factors, resulting in the same groundwater type of the test plot in the number of electrodynamic folding coefficients is not completely in proportion to the water richness of its region, there is a certain degree of volatility.

(1) In the study area, the number of electrodynamic folding coefficients is generally higher in the pressurised water area than in the submerged water area; the number of electrodynamic folding coefficients in the clastic type area is higher than that in the basalt type area and higher than that in the loose rock type area, and higher than that in the bedrock fissure water type area.

(2) Topography and geomorphology have a greater influence on the number of electro-hydrodynamic systems. Low-lying areas are generally richer in groundwater, and the number of electrically-operated wells is higher; mountainous, hilly and highland areas are generally poorer in groundwater, and the number of electrically-operated wells is smaller. Even in high altitude areas with flat terrain, the EWRFs are still poor. And in the case of the same type of groundwater, the electric discount factor of electromechanical wells is more obviously affected by topography and landscape.

(3) Atmospheric precipitation, as one of the main recharge methods for all groundwater types, has a very limited effect on the EWD. Whether atmospheric precipitation can effectively recharge groundwater and be reflected in the number of electrically discounted water coefficients of electromechanical wells mainly depends on the water richness of the groundwater type. According to the analysis, it can be seen that the ability of precipitation and evaporation in the region to influence the number of water discounting systems is smaller than that of topography and groundwater type.

(4) The better the agricultural development, the better the irrigation facilities such as electromechanical wells and pumps are, and the higher the EWF.

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