WQ Monitoring Plan in Shiyang River Basin

Zhang Zhechen

Student number: 1074448

Locker number: 336

1. Objectives

1.1 Introduction of Shiyang River

Shiyang River is an inland river in northwest China. Most of the basin is located in Gansu province. The river system is mainly supplied with rainwater, combined with snow and ice meltwater, with an annual runoff of 1.591 billion cubic meters. The upper reaches of the Qilian Mountains are rich in precipitation, which is the water supply area of the river. The middle reaches are through the area called the Hexi Corridor, which forms Wuwei and Yongchang oasis. Thus, in the middle part of the catchment, the irrigation agriculture flourished. The downstream of Shiyang River disappears between the Badain jaran Desert and the Tengger Desert, and the end of Shiyang River is Qingtu Lake below the Minqin oasis. Qingtu Lake, which shrank and disappeared in the early 2000s, has begun to return to the surface water in recent years under Chinese government control.

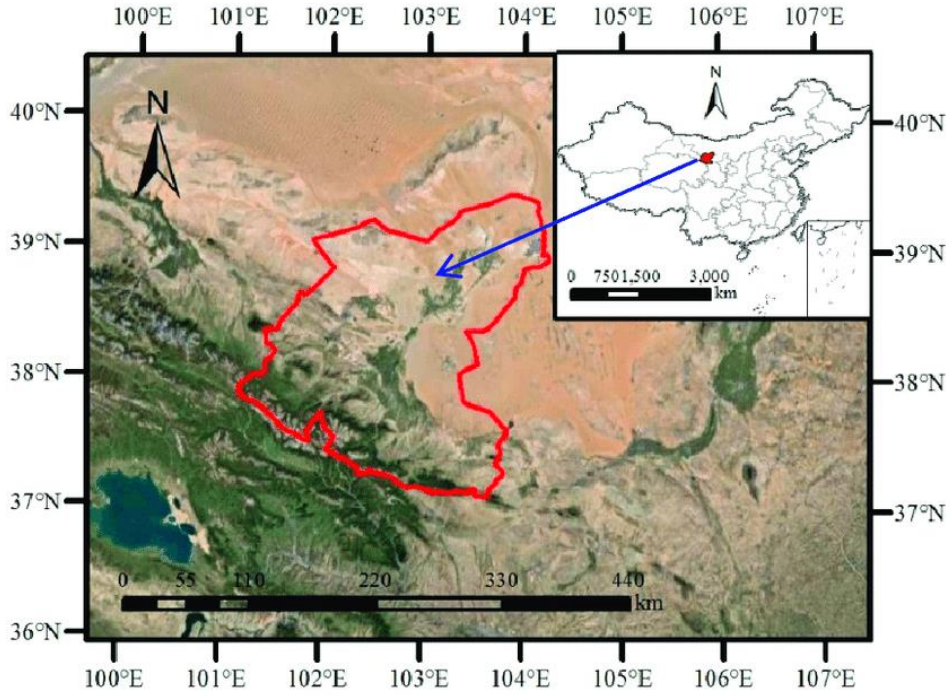

Figure 1.1 the topographic map of Shiyang River and the location in China(Yang et al., 2018)

The Chinese government has set up a special management body for the basin, the Shiyang River basin management committee, which is affiliated with the water resources department of Gansu province. The water quality monitoring system is also regulated by the committee, which governs all water-related matters in the basin.

1.2 Legal basis

Water Law of the People's Republic of China

Law of the People's Republic of China on Water Pollution Control

Regulation for water environmental monitoring in PRC

1.3 Water issues in the basin

The industrial structure of this basin is dominated by agriculture, and irrigation agriculture is very developed, but it also brings a lot of problems. Therefore, the most important issue in this region is how to ensure the quality of agricultural water, how to control the impact of agricultural sewage on the water quality in the basin, and how to balance the relationship between agricultural development and water quality. For ecology, the basin is located in a semi-arid region, and Qingtu Lake separates China's two deserts, making the area ecologically fragile but important. The first question about ecology is the effect of water quality changes in the Qilian Mountains on the downstream. Another issue is the role of changes in Qingtu Lake's ecology in preventing the two deserts from connecting. For life, people are mainly concerned about the water supply in urban and rural areas, whether the water quality meets the drinking water standards. The area is a major producer of nonferrous metals in China, and how industrial wastewater affects water quality is another concern.

In order to address the questions, we need to know the land use, the industrial distribution, the distribution of sewage outlets, the distribution of water sources, and the water quality in different areas. The water quality data we need are the water quality data of the important points of the river (such as the river control station, Qingtu Lake, etc.), water supply source, the industrial sewage outlet, and the upstream and downstream of the agricultural irrigation area, etc. In this information, we have mastered the basic data of terrain, land use, industrial distribution, and others. The missing data is the water quality data provided by the water quality monitoring network in this report.

1.4 Conceptual model

The conceptual model of the Shiyang River basin is shown in the following figure. It can be seen from the figure that the mountainous area in the southwest of the basin is a stream-producing area. The river originates from different locations and ends up in the

Hongyashan reservoir. Only the mainstream of the Shiyang river exists below the Hongyashan reservoir, with no other tributaries. The upper reaches are high in elevation, sparsely polluted, with little human activity and population. The middle part of the Shiyang River is the main source of pollution. And the most contaminant comes from the irrigated area, which is concentrated in this area. The city is also concentrated in this area, the city water intake and the pollution from the city occur in this area. In addition, heavy industry enterprises in Jinchang and Wuwei also bring a certain amount of pollution. Below the Hongyashan reservoir, the Shiyang River is close to the end Qingtu Lake, which is an ecologically important area and a key conservation area of the basin. Pollution in the middle reaches reduced below the Hongyashan reservoir. At the same time in the Minqin area also has the discharge of agricultural sewage. In general, the conceptual model is to produce water in the upper reaches without human pollution, increase contamination in the middle reaches, increase some water in the lower reaches, and reduce pollution from the middle reaches. However, the downstream areas have the highest environmental protection requirements.

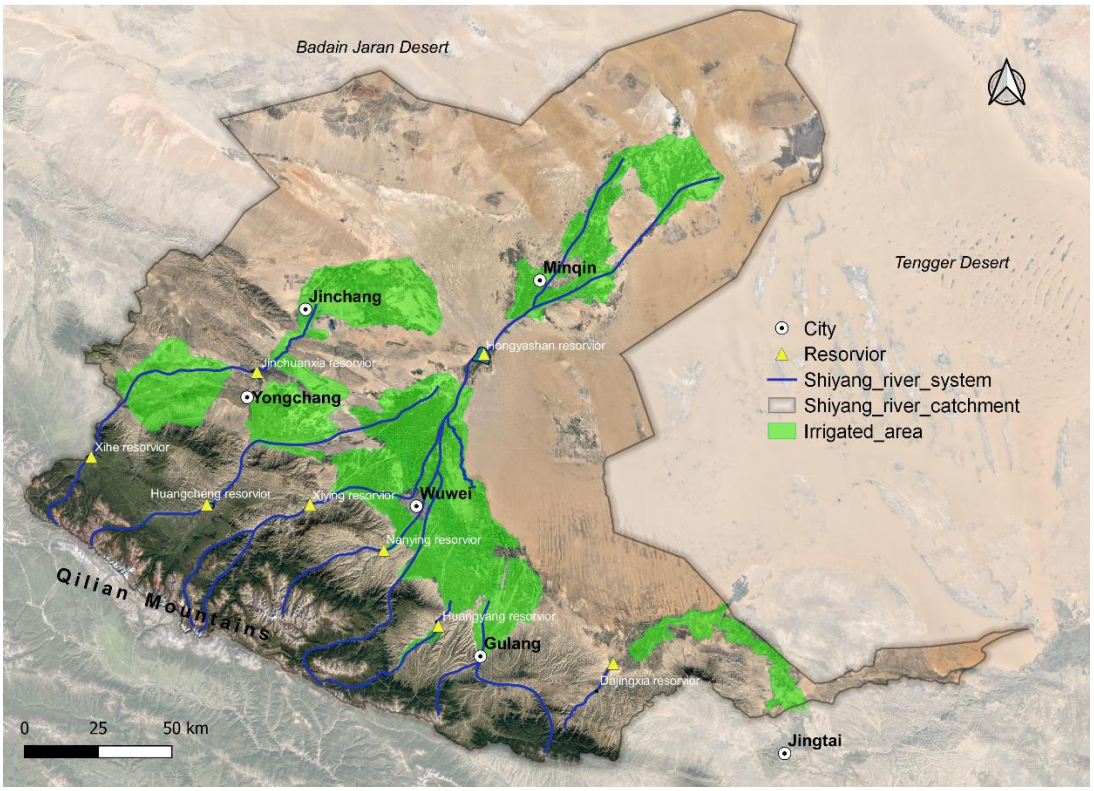

Figure 1.2 the conceptual model of Shiyang River

1.5 Concise list of objectives

The total objective of the Shiyang River WQ monitoring system is to provide water quality information for different aspects:

- To ensure water quality requirements for agricultural irrigation.
- To monitor the water quality and ecological changes in the upper Qilian Mountain and the Qingtu Lake.
- To ensure the safety of drinking water supply.
- To monitor the impact of human activities (agriculture, livelihood, industry) in the middle reaches on the water quality of the watershed.
- To analyze the change of contaminant in the basin space scale

2. Location of monitoring stations

The location of the Shiyang River water quality monitoring system stations is shown in the following figure 2.1 and table 2.1. A total of 28 stations are set up in this system, which is divided into five categories. Stations 1-8 located in the reservoir are the reservoir water quality monitoring station. Station 4 and 5 are also located in the upper reaches of the river basin and are responsible for monitoring the ecological changes in the upper reaches. Stations 1, 2, 6, 7, and 8 are located in reservoirs with the task of supplying water to the cities or to the irrigation areas, so these stations are also responsible for monitoring the safety of water supply. Station 9-16 is the known source of drinking water in the basin, including the direct water intake point of the river, as well as the urban water supply plant. This part of the stations is concentrated in the outflow pass of the river because the outflow pass is rich in water and relatively good in quality. While in the lower reaches of the Shiyang river basin, most of the drinking water comes from groundwater. The third category of monitoring stations is those that focus on ecological changes in the watershed. Among them, the measuring stations 17 and 18 are located in the upper reaches of the river, which are concerned with the ecological changes in the upstream stream-producing area, while the measuring stations 19 and 20 are located in the Minqin area at the end of the river, which reflect the water quality characteristics of Qingtu lake. The unstable surface of Qingtu Lake could not guarantee the time of surface water occurring, so the measuring station reflecting the water quality at the end of the river was placed in the Minqin area. Stations 21-27 reflect the influence on water quality by using water in agriculture, industry, and livelihood. The stations 21 and 25 monitor the water quality before flow entering the cities. And the stations 22, 24, 25, and 26 observe the water quality before the river into the irrigation area. The stations and 27 are both located at the outlet of the irrigation area of tributaries, which strict monitoring agricultural sewage for the influence of Shiyang catchment. The last type is the most important station in the basin, Caiqi station. Caiqi station is the watershed control hydrology station in the Shiyang

River basin. The middle and upper reaches of the river and contaminate converges at Caiqi station and then spreads to the lower reaches. Therefore, Caiqi station is the station that reflects the overall pollution situation in the middle and upper reaches of the whole basin.

Table 2.1 the location of water quality monitoring stations

Number	Name	Longtitude	Latitude	Major type	Secondary type	Sample amounts
1	Hongyashan resorvior	102.89	38.41	Resorvior	Water use influence	5
2	Huangyang resorvior	102.72	37.57	Resorvior	Water use influence	2
3	Dajingxia resorvior	103.34	37.37	Resorvior		2
4	Huangcheng resoirvior	101.85	37.91	Resorvior	Ecology	2
5	Xihe resorviore	101.38	38.05	Resorvior	Ecology	2
6	Jinchuanxia resorvior	102.02	38.33	Resorvior	Water use influence	2
7	Xiying resorvioir	102.23	37.92	Resorvior	Water use influence	2
8	Nanying resorvior	102.52	37.79	Resorvior	Water use influence	2
9	Zamu river intake 1	102.59	37.44	Drinking water		1
10	Huangyang river intake	102.58	37.7	Drinking water		1
11	Zamu river intake 2	102.55	37.67	Drinking water		1
12	Jinta river intake	102.52	37.79	Drinking water		1
13	Xiying river intake	102.32	37.95	Drinking water		1
14	Wuwei city intake	102.56	37.7	Drinking water		1
15	Yongchang city intake	101.99	38.18	Drinking water		1
16	Jinchuanxia resorvior intake	102.02	38.33	Drinking water		1
17	Jiutiaoling	102.04	37.86	Ecology		1
18	Maozangsi	102.44	37.51	Ecology		1
19	Minqin west	103.32	38.91	Ecology		1
20	Minqin East	103.62	38.9	Ecology		1
21	Ningyuanbao	102.19	38.46	Water use influence		1
22	Tuanzhuang	102.29	37.94	Water use influence	Discharge station	1
23	Sibaqiao	102.67	38.08	Water use influence	Discharge station	1
24	Zamusi	102.58	37.7	Water use influence	Discharge station	1
25	Gulang	102.89	37.45	Water use influence		2
26	Toukoubazi	101.99	38.1	Water use influence	Discharge station	1
27	Hongshui river	102.75	38.17	Water use influence	Discharge station	2
28	Caiqi	102.75	38.21	Control station		3

The amounts of sampling sites of each station are also shown in the last column of Table 2.1. For the reservoir, we need the water quality of inflow and outflow. Hongyashan reservoir is the only oversize reservoir in this basin, and its geographical location is important, which carries all the pollutants in the upper and middle reaches and controls the water quality of the Minqin oasis. Therefore, the Hongyashan reservoir chooses five sampling sites. Most stations on rivers choose a sampling section. Three different sampling sections are taken in Caiqi station because of its importance. Since measuring stations 25 and 27 are tributary input areas, two sampling sections should be selected before and after the tributary input.

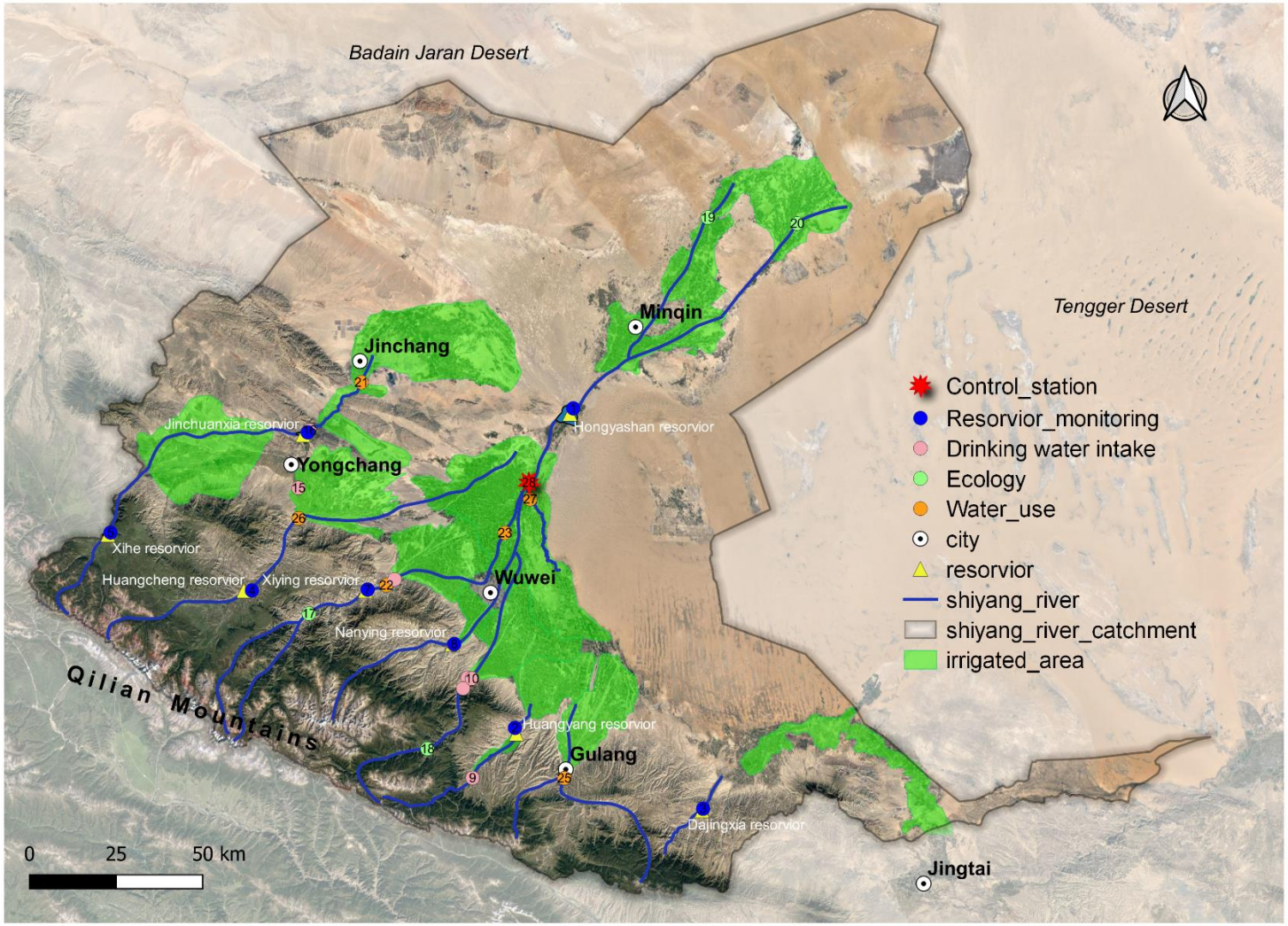

Figure 2.1 the location of water quality monitoring stations

3. Schedule of monitoring activities

The measurement frequency of each station is shown in the following table. Because water quality has a great impact on this area and is of high importance, most stations choose to test once a month, which is also the national standard of China for the monitoring frequency of important water quality testing stations(department, 2018) For Caiqi station, the most important station, I choose to increase the frequency of measurement and choose the frequency every half a month. The function of the Dajingxia reservoir in station 3 has been replaced by the water diversion project from Yellow River, so station 3 is monitored at a low frequency once every two months. Dajingxia reservoir used to be the water source of the Jingtai irrigation area. Now the water source of the Jingtai irrigation area is from the Yellow River instead of the water from the Dajingxia reservoir. For station 18, since the transportation is not particularly convenient in the Qilian Mountains, the lower measurement frequency is also used. It is important to note that the above is only the regular measurement frequency. Under extreme conditions, additional measurements are needed for each station, mainly for each reservoir and mainstream important control station during the flood. Stations and water supply stations in downstream Minqin areas are not measured during dry periods or when there is no drinking water supply.

Table 3.1 the schedule of monitoring activities in the Shiyang River WQ monitoring plan

Number	Name	Major type	Frequency	Note
1	Hongyashan resorvior	Resorvior	every month (12/year)	Flooding time testing
2	Huangyang resorvior	Resorvior	every month (12/year)	Flooding time testing
3	Dajingxia resorvior	Resorvior	ebery two month (6/year)	Flooding time testing
4	Huangcheng resoirvior	Resorvior	every month (12/year)	Flooding time testing
5	Xihe resorviore	Resorvior	every month (12/year)	Flooding time testing
6	Jinchuanxia resorvior	Resorvior	every month (12/year)	Flooding time testing
7	Xiying resorvioir	Resorvior	every month (12/year)	Flooding time testing
8	Nanying resorvior	Resorvior	every month (12/year)	Flooding time testing
9	Zamu river intake 1	Drinking water	every month (12/year)	No water ssupplying no testing
10	Huangyang river intake	Drinking water	every month (12/year)	No water ssupplying no testing
11	Zamu river intake 2	Drinking water	every month (12/year)	No water ssupplying no testing
12	Jinta river intake	Drinking water	every month (12/year)	No water ssupplying no testing
13	Xiying river intake	Drinking water	every month (12/year)	No water ssupplying no testing
14	Wuwei city intake	Drinking water	every month (12/year)	No water ssupplying no testing
15	Yongchang city intake	Drinking water	every month (12/year)	No water ssupplying no testing
16	Jinchuanxia resorvior intake	Drinking water	every month (12/year)	No water ssupplying no testing
17	Jiutiaoling	Ecology	every month (12/year)	
18	Maozangsi	Ecology	every two month (6/year)	
19	Minqin west	Ecology	every month (12/year)	No surface water no testing
20	Minqin East	Ecology	every month (12/year)	No surface water no testing
21	Ningyuanbao	Water use influence	every month (12/year)	
22	Tuanzhuang	Water use influence	every month (12/year)	
23	Sibaqiao	Water use influence	every month (12/year)	
24	Zamusi	Water use influence	every month (12/year)	
25	Gulang	Water use influence	every month (12/year)	
26	Toukoubazi	Water use influence	every month (12/year)	
27	Hongshui river	Water use influence	every month (12/year)	
28	Caiqi	Control station	every half month (24/year)	

4. Parameters to be monitored

The parameters to be measured for each station are shown in the following table. The parameters monitored at each station differ according to the source of contamination. The basic parameters that every station needs to measure are temperature, pH, electrical conductivity, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, total nitrogen, total phosphorus, and total suspended solids. Stations 3, 4, 5, 7, 8, 17, 18, 22, 24, 25, and 26 are only required to measure these basic elements because most of them are located in the middle and upper reaches of the river basin and are basically free from human pollution. For stations 2 and 6, which are dominated by agricultural pollution, we need to increase the measurement of nitrate, ammonia nitrogen, turbidity, oregano chlorines, oregano phosphates, and bacteria. For the stations with simultaneous agricultural and industrial pollution 21, 23 and 27, we need to measure heavy metals on the basic parameters under the agricultural pollution, because the pillar industry in this basin is non-ferrous metal mining and processing. For drinking water, all the above elements need to be measured except for ammonia nitrogen, which is not included in China's drinking water standards. In addition, three toxicants, sulfide, fluoride, and cyanide, should be tested for drinking water. Finally, I choose to measure all the above parameters for the four important stations, 1,19,20,28, located in the downstream of the basin, because the downstream would receive all the pollution of the whole basin. In addition, at the river station, we also need to measure the flow discharge and velocity to match the analysis of water quality. The stations located in the reservoir do not need to measure the flow and velocity, and can directly use the operation data of the reservoir.

Table 4.1 the parameters to be monitored in the Shiyang River WQ monitoring plan

Number	Name	Major type	Discharge	Velocity	Temperature	pH	EC	DO	BOD	COD	TN	TP	TSS	NO3-	NH4+	Turbility	Sulfide	Fluuoride	Cyanide	Heavy metal	Organo chlorines	Organo phosphates	Bacteria
3	Dajingxia resorvior	Resorvior			√	√	√	√	√	√	√	√	√										
4	Huangcheng resoirvior	Resorvior			√	√	√	√	√	√	√	√	√										
5	Xihe resorviore	Resorvior			√	√	√	√	√	√	√	√	√										
7	Xiying resorvioir	Resorvior			√	√	√	√	√	√	√	√	√										
8	Nanying resorvior	Resorvior			√	√	√	√	√	√	√	√	√										
17	Jiutiaoling	Ecology	√	√	√	√	√	√	√	√	√	√	√										
18	Maozangsi	Ecology	√	√	√	√	√	√	√	√	√	√	√										
22	Tuanzhuang	Water use influence	√	√	√	√	√	√	√	√	√	√	√										
24	Zamusi	Water use influence	√	√	√	√	√	√	√	√	√	√	√										
25	Gulang	Water use influence	√	√	√	√	√	√	√	√	√	√	√										
26	Toukoubazi	Water use influence	√	√	√	√	√	√	√	√	√	√	√										
2	Huangyang resorvior	Resorvior			√	√	√	√	√	√	√	√	√	√	√	√					√	√	√
6	Jinchuanxia resorvior	Resorvior			√	√	√	√	√	√	√	√	√	√	√	√					√	√	√
21	Ningyuanbao	Water use influence	√	√	√	√	√	√	√	√	√	√	√	√	√	√				√	√	√	√
23	Sibaqiao	Water use influence	√	√	√	√	√	√	√	√	√	√	√	√	√	√				√	√	√	√
27	Hongshui river	Water use influence	√	√	√	√	√	√	√	√	√	√	√	√	√	√				√	√	√	√
9	Zamu river intake 1	Drinking water			√	√	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√
10	Huangyang river intake	Drinking water			√	√	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√
11	Zamu river intake 2	Drinking water			√	√	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√
12	Jinta river intake	Drinking water			√	√	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√
13	Xiying river intake	Drinking water			√	√	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√
14	Wuwei city intake	Drinking water			√	√	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√
15	Yongchang city intake	Drinking water			√	√	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√
16	Jinchuanxia resorvior intake	Drinking water			√	√	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√
1	Hongyashan resorvior	Resorvior			√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
19	Minqin west	Ecology	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
20	Minqin East	Ecology	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
28	Caiqi	Control station	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

5. Budget

Table 5.1 the analytical cost in the Shiyang River WQ monitoring plan

Number	Temperature	pH	EC	DO	BOD	COD	TN	TP	TSS	NO3-	NH4+	Turbility	Sulfide	Fluuoride	Cyanide	Heavy meta	Organo chlorines	Organo phosphates	Bacteria	Sum	Frequency	Sample amounts	Sum($)
	Price per tese($/time)																						
1	11	11	11	11	49.5	49.5	33	33	22	22	22	13.2	24.2	22	55	11	71.5	71.5	38.5	581.9	12	5	34914
2	11	11	11	11	49.5	49.5	33	33	22	22	22	13.2					71.5	71.5	38.5	469.7	12	2	11272.8
3	11	11	11	11	49.5	49.5	33	33	22											231	6	2	2772
4	11	11	11	11	49.5	49.5	33	33	22											231	12	2	5544
5	11	11	11	11	49.5	49.5	33	33	22											231	12	2	5544
6	11	11	11	11	49.5	49.5	33	33	22	22	22	13.2					71.5	71.5	38.5	469.7	12	2	11272.8
7	11	11	11	11	49.5	49.5	33	33	22											231	12	2	5544
8	11	11	11	11	49.5	49.5	33	33	22											231	12	2	5544
9	11	11	11	11	49.5	49.5	33	33	22	22		13.2	24.2	22	55	11	71.5	71.5	38.5	559.9	12	1	6718.8
10	11	11	11	11	49.5	49.5	33	33	22	22		13.2	24.2	22	55	11	71.5	71.5	38.5	559.9	12	1	6718.8
11	11	11	11	11	49.5	49.5	33	33	22	22		13.2	24.2	22	55	11	71.5	71.5	38.5	559.9	12	1	6718.8
12	11	11	11	11	49.5	49.5	33	33	22	22		13.2	24.2	22	55	11	71.5	71.5	38.5	559.9	12	1	6718.8
13	11	11	11	11	49.5	49.5	33	33	22	22		13.2	24.2	22	55	11	71.5	71.5	38.5	559.9	12	1	6718.8
14	11	11	11	11	49.5	49.5	33	33	22	22		13.2	24.2	22	55	11	71.5	71.5	38.5	559.9	12	1	6718.8
15	11	11	11	11	49.5	49.5	33	33	22	22		13.2	24.2	22	55	11	71.5	71.5	38.5	559.9	12	1	6718.8
16	11	11	11	11	49.5	49.5	33	33	22	22		13.2	24.2	22	55	11	71.5	71.5	38.5	559.9	12	1	6718.8
17	11	11	11	11	49.5	49.5	33	33	22											231	12	1	2772
18	11	11	11	11	49.5	49.5	33	33	22											231	6	1	1386
19	11	11	11	11	49.5	49.5	33	33	22	22	22	13.2	24.2	22	55	11	71.5	71.5	38.5	581.9	12	1	6982.8
20	11	11	11	11	49.5	49.5	33	33	22	22	22	13.2	24.2	22	55	11	71.5	71.5	38.5	581.9	12	1	6982.8
21	11	11	11	11	49.5	49.5	33	33	22	22	22	13.2				11	71.5	71.5	38.5	480.7	12	1	5768.4
22	11	11	11	11	49.5	49.5	33	33	22											231	12	1	2772
23	11	11	11	11	49.5	49.5	33	33	22	22	22	13.2				11	71.5	71.5	38.5	480.7	12	1	5768.4
24	11	11	11	11	49.5	49.5	33	33	22											231	12	1	2772
25	11	11	11	11	49.5	49.5	33	33	22											231	12	2	5544
26	11	11	11	11	49.5	49.5	33	33	22											231	12	1	2772
27	11	11	11	11	49.5	49.5	33	33	22	22	22	13.2				11	71.5	71.5	38.5	480.7	12	2	11536.8
28	11	11	11	11	49.5	49.5	33	33	22	22	22	13.2	24.2	22	55	11	71.5	71.5	38.5	581.9	24	3	41896.8
	Total analytical cost for one year																						233112

Table 5.2 the budget in the Shiyang River WQ monitoring plan

Term	Price per unit	Amount	Cost($)
Staff time	50	1500	75000
Staff diem	40	336	13440
Verhicle use	100	336	33600
Discharge station	5000	12	60000
Maintenance	300	12	3600
WQ meterial and suplly	25	336	8400
Analytical cost	-	-	233112
Total cost of WQ monitoring plan			427152

6. Bibliography

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