

TAMPERE UNIVERSITY OF APPLIED SCIENCES  
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Bachelor's Thesis  
Wang Zhe

## **CAOHAI DIANCHI LAKE WATER POLLUTION CONTROL PLAN**

Supervisor  
Commissioned by  
  
Tampere 2010

Principle Lecturer Director Marjukka Dyer  
Yunnan Provincial Environmental Protection Bureau,  
supervised by Director Jinwei Li

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Environmental Engineering

Wang Zhe	Caohai Dianchi Lake water pollution control plan
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## **ABSTRACT**

Caohai is located in the lowest of Lake Dian area, and is in this region the only wastewater containing water body. Lake Dian is in the natural succession process and has entered a period of aging and eutrofication. The lake is shallow lake, and therefore the lake water self-purification ability is weaker and weaker. The major rivers into Lake Dian run through some urban areas, villages, farms, industrial areas; therefore a large number of hazardous substances and nutrients are carried from those places into Caohai. With the growth of population around the river basin and growing urbanization, also the change of production and lifestyle, the pollution of lake water is rapidly increasing at present. . Until now the quality of the lake water is much worse and the water has been severely pollution. So Caohai is the serious pollution source in Lake Dian area, and therefore it is the focus of pollution control in Lake Dian.

The aim of this plan is to find some solutions to above problems, and a keystone of the integration treatment that could be implemented in the control of urban pollution. The importance of giving more attention to the ecological restoration and treatment of water in order to reach the good treatment methods to get observable effects is obvious. .

Most of the material of this thesis come from the office records and have not been published elsewhere.

## FOREWORD

In July 2002, I graduated from Affiliated Senior High School of DaLian Girl Vocational Technology College in China, with High Distinction. Afterwards, I had worked at Dalian Economic and Technology Development Zone Pengyu Forwarding Co. Ltd for two years. In year 2004 I had been a first year degree student of Business Management in Kemi-Tornio Polytechnic. In year 2005 I have been a transfer student of Bachelor Degree in Environmental Engineering in Tampere University of Applied Sciences.

Thanks to my superiors in Yunnan Provincial Environmental Protection Bureau, they have provided me a position to complete my practical training in Yunnan Provincial Environmental Protection Bureau. I have always been encouraged to do several projects with them about energy management research works, aquatic resources protection, and the eco-village planning. During the practical training, I accumulated a lot of work experiences and knowledge about environmental engineering.

I really would like to thank the Director of Degree Programme, Marjukka Dyer, for her trust, understand and kindly help, I can graduate sooner than expected. And also I would like to thank all of the teachers in TAMK, because of their patient and rich in content of teaching, which endows me with a broader vision and more profound insights in my future work.

Tampere, January 2010

Wang Zhe

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## 1. Introduction

Kunming is located in the middle of Yunnan-Guizhou Plateau, the elevation of city center is 1891m, the south of Kunming is near Lake Dian, and other three sides are surrounded by mountains. Kunming is China's famous historical and cultural city and also is a renowned tourist city.

The Lake Dian which near Kunming is well-known plateau freshwater lakes, with a number of functions such as urban water supply, agricultural water storage, flood control, tourism, aquaculture, regulation of climate. It is the basic lake of Kunming's survival and development. Caohai is an important part of Lake Dian, the lake area 10.8m<sup>2</sup>, and Caohai's area is 195m<sup>2</sup>.

Caohai is located in the lowest of Lake Dian area, and this region is the only body of wastewater. Lake Dian in the natural succession process, has entered a period of aging, shallow lake, the lake water self-purification ability is weaker and weaker. The major rivers into Lake Dian are main run through some urban areas, villages, farms, industrial areas; therefore a large number of hazardous substances and nutrients were carried from those places into Caohai. With the growth of population around river basin and urbanization, also the change of production and lifestyle, the pollution of lake water is rapid growth nowadays. Until now the quality of the lake water is very worse and the water has been severe pollution. So Caohai is the serious pollution in Lake Dian area, and also it is the focus of pollution control in Lake Dian.

### The Aim of This Plan

Because of the water pollution, there have some environmental issues as following:

- The environmental content of Caohai cannot afford to the pollution load
- The mostly pollution of Caohai is come from city pollution
- The contamination run through the river into Caohai
- The lack of water resource lead to serious polluted of pathway river
- The serious destroy of ecosystem will severity affect the life quality of human who living around Lake Dian

The aim of this plan is to solve above problems, and the keystone of the integration treatment is implementation control of urban pollution, and then we should pay more attention on the ecological restoration and replacement of water to reach the end of the treatment, to get an observably effect.

## 2. River Basin Environmental Systems Analysis

### 2.1 Natural Environment Overview

#### 2.1.1 Location

Caohai is located in the west suburbs of Kunming, is the southernmost of Caohai basin, for the basin's lowest point. Caohai basin is in northwestern part of the Dianchi Lake area, located in the Dianchi Lake is the Yangtze River Jinsha River, is located in the Yangtze River, Zhu River, and Red River watershed in the three major river systems area. Caohai are under construction within the region of high sea-road, the proposed route east to west across the South Ring Caohai, a number of roads and railways crisscross in the region, transportation is very convenient.

#### 2.1.2 Geological features

Dianchi Lake is located in Yunnan-Guizhou Plateau, basically there are gentle slope terrain, mainly belong to Zhongshan landforms, northwest of the King of Liang Shan and western AiLaoshan are the dividing line between 2825 ~ 3143m, they are elevation the uplift of the southwest warm and humid air or part of the barrier; Eastern Wumeng shan between 2358 ~ 3100m, can prevent the invasion of the northern cold air and elevation warm and humid air from the eastern side, resulting in the whole regions are mild and humid.

#### 2.1.3 Meteorological Climate

Caohai basin is the north sub-tropical humid climate, the annual average temperature is 14.7 °C, annual accumulated temperature is 4200 ~ 4500 °C. Annual dry season is November until the following year to May, the wet season is June to October, the annual average relative humidity: 73 ~ 74 %. During so many years, the average annual rainfall is 797 ~ 1007mm. The average annual surface evaporation: 1870 ~ 2120mm, a very uneven distribution of rainfall during the year, 80% of the rainfall concentrated in the rainy season, resulting in winter is very dry but summer is very wet, wet and dry is very clear. The number of annual sunlight is 2081 ~ 2470hr, and annual sunlight rate is 47% ~ 56%, annual frost-free period is 227 days, with an average annual fog days for 56 days. Annual average atmospheric pressure is 811.0 hPa. During so many years the mean wind speed: 2.2 ~ 3.0m / s, dominant wind direction is south-west winds.

#### 2.1.4 Hydrology and water system

Caohai basin area is 195km<sup>2</sup>; many years the average runoff volume is about 86.4 million m<sup>3</sup>. The entry into the Caohai lake's rivers are: boats rooms river, Xiba river, Grand river, Wulong River, Old River and New river, Wangjia river and other seven rivers. Within the basin there have northwest of Shahe reservoir, yellow slope reservoir, Zhaozong reservoir, the water eventually import to the new river, after that they will flows to northwest of Caohai. The water will eventually flow into the Jinsha River.

Caohai is take up accounting for 3.6% of the Dianchi Lake water area, the length of north to south is about 7.4km, the width of east to west is 2.25km, the narrowest is about 0.12km, the average depth of Caohai is 3.0m, shoreline length is 23km, water storage capacity is 25.17 million m<sup>3</sup>, take up 2.67% volume of water in Dianchi Lake. Every year in January to April, November and December, Caohai is in the water storage phase, the normal water level is 1886.80m, it is below the sea level 0.8m, when in May to October, and Caohai is in the flood protection period, during the whole period water level is limit for 1885.80m, less than sea water level 1.3m.

The area of Dianchi Lake is windy areas, wind and waves off the coast, during strong wind period, a larger wave height will up to 1.2m, the wavelength will in excess of 10m. But inside of Caohai the water flow is really slow.

#### 2.1.5 Soil and vegetation

Dianchi Lake Basin have 7 different types of soils, they are: brown soil, yellow brown soil, original red soil, purple soil, alluvial, swamp soil, paddy soil. Because of biological, climate, topography, and other factors, the soil vertical distribution as follows: in the high mountain regions, the elevation is above 2600m the soil is brown; mountainous regions with the yellow brown soil, original red soil, but purple soil based; platform with red soil, paddy soil-based; lake plain with paddy soil, alluvial, swamp soil, these soil are high fertility, and rich of nitrogen, phosphorus and organic matter content.

Vegetation is related to climate, soil and human production activities. The mountain land area of Caohai basin is basically compose by a type of natural ecosystems, forest coverage rate of Dianchi Lake is 32.9%, but the native vegetation types already almost loss, a large number of vegetation are Pine trees, those kind of secondary vegetation. Mesa are widely distributed of irrigated grass, accounting for 20.1% of the regional area, followed by woodland, and coniferous forests accounted for 12.4% and 13.7%, agricultural land accounted for 38.8%. Lake plain area dominated by farmland, the largest area is paddy field, accounting for 75% of farmland. Dry land, orchards are located in low hills and the lake edge of the plateau.



## 2.2. Socio-economic analysis of Caohai basin

### 2.2.1 Socio-economic Status

#### 2.2.1.1 Population Distribution

##### (1) Administrative division

After the adjustment of Kunming administrative division, Dianchi Lake Caohai zone involving Xishan, Wuhua, 13 sub district offices, involving two towns with Biji and Tuanjie, there have 120 neighborhood committees, 4 village committees. The table will show as follow:

Canton	Sub district offices	Neighborhood committees	Area ( km2 )
West Mount ain Area	Jinbi offices	Jinbi,Fuxing,Desheng Bridge,Xunjin new town,Shulinstreet,Dongsi steet,Xiyuemiao,Ankang,Gongrenxincun,Qixianglu,Lujiaying,Xibabei,Xibanan,Milesi,Henan	4.58
	Yongchang offices	Yongshunli,YongxingRoad,YikangRoad,Huang guaying,Luosiwan,Yongningli,Yunfang,Jinhuazhenzhi,Yongheli,Yonglian,Majia	3.88
	Qianwei offices	Majia,Guanzhuang,Nanba	20.94
	Fuhai offices	Chuanfang,Fujia,Lujia,NewRiver,HebeiCommittees	27
	Zongshuying offices	ZongshuyingSouthArea,ZongshuyingNorthArea,BaimaEastArea,BaimaWestArea,YuchiRoad,Tudui,Jinhuapu,Medical College	5.03
	Majie offices	Liangyuan,Mingbo,Jishan,Chunyuan,Zhangfeng,Majie,Dayu,Puping,Xiliyuan,Deyuan	32.81
	Biji Town	Biji,Longmen and so on	88.6
	Tuanjie Town	Huahongyuan,Sanjiacun	254.8
Wuhua Area	Huguo offices	Huguo Bridge,Xiangyun Street,Baoshan street,Wenmiao,Guanghua street,Ruyixiang,Quanxuexiang,Weiyuan Street,Jingxing Street,Jinniu Street, Jiexiaoxiang	1.89

	Daguan offices	Sanheyang, Dongfengxiluzhongduan, Shuncheng, Wuyi Road, Fuchun, Shengwei, Zhuantang, Jiangongxin, News Road, Daguanshangyecheng, Daguan Road, Zongshuying East Area	2.78
	Huanshan offices	Qingyun, Beimen, Shuijingong, Huashanxilu, Qjuxiang, Yuantongdong, Huashan, Tianjundianxiang, Cunhunanlu, Yunshida, Minzudaxue, Wenlin, Yunda, Honghua Bridge, Yuanxi	3.86
	Fengning offices	Hongshan Middle Road, Hongshan East Road, Hongshan South Road, Kunjian Road, Chunhui, Fengming South, Fengning North, Hongyuan, Huangtupo	7.97
	Longxiang offices	Renmin West Road, Panjiawan, Longxiang, West Station, Jiaoling, Honglian, Hongling Road, Jiaolingtang, Xiyuan North Road	3.95
	Puji offices	34 neighborhood committees	30.72
	Heilinpu offices	Zhaozong, Tuanshan, Haiyuan, Minshan, Heilinpu, Longyuan, Zhangfeng, Liangyuan Committees and Kunming 8 Committees	31.15

Administrative division conditions are shown in Table 2-2-1.

## (2) Population Statistics

Planning area's total population is the sum of resident population and floating population. Based on economic work in 2006, the planning area of Caohai total population is 1.1765 million, of which the resident population is 1.0695 million people; mobile population is 10.7 million people. Involved in Xishan residence population is 257,636, of which agricultural population is 23772 people, the person who live more than six months transient population is 200,626 people; Wuhua area residence population is 470,028, of which agricultural population is 25004 people, the person who live more than six months were 141,225 they are all temporary residents. We can see the population statistics table as following:

Canton	Sub district offices	Total population at the end of the year	Register population at the end of the year	Agriculture population	Temporary residents	Floating population
West	Jinbi offices	112807	102552	-	-	10255

Mounta in Area	Yongchang offices	80739	41447	-	31952	7340
	Qianwei offices	32832	3630	1279	26217	2985
	Fuhai offices	85182	13879	8667	63559	7744
	Zongshuying offices	69266	34888	-	28081	6297
	Majie offices	117731	56211	11367	50818	10703
	Biji Town	4128	3753	1378	-	375
	Tuanjie Town	1403	1276	1081	-	128
	<b>Account</b>	<b>504088</b>	<b>257636</b>	<b>23772</b>	<b>200626</b>	<b>45826</b>
Wuhua Area	Huguo offices	96052	87320	-	-	8732
	Daguan offices	107072	97338	-	-	9734
	Huanshan offices	100589	91445	-	-	9144
	Fengning offices	92691	44203	-	40062	8426
	Longxiang offices	55900	50818	-	-	5082
	Puji offices	110448	43339	18000	57068	10041
	Heilinpu offices	109626	55565	7004	44095	9966
	<b>Account</b>	<b>672378</b>	<b>470028</b>	<b>25004</b>	<b>141225</b>	<b>61125</b>
<b>Total Account</b>		<b>1176466</b>	<b>727664</b>	<b>48776</b>	<b>341851</b>	<b>106951</b>

Planning area's Population Statistics Table 2-2-2.

### 2.2.1.2 Socio-economic overview

In 2007 Wuhua to realize an annual GDP 30.2166 billion Yuan, per capita GDP is 346.24 million Yuan; local financial revenue 788 million, fiscal spending 898 million Yuan, local fiscal income of 902 Yuan per capita; agriculture, forestry and fishing output value are 1.743 billion; farmers per capita net income of 4154 Yuan; total retail sales of 13.859 billion Yuan of social consumer goods. This planning area has become the fastest-growing, the largest and most dynamic economic sectors region. The development of this area have deeply potential.

2007 with a development of Kunming planning area, there have a lot chances in economy area. Realized a GDP of 12.473 billion Yuan annually; per capita gross domestic product 184.79 million Yuan; local financial revenue 690 million Yuan, fiscal spending 659 million Yuan, local fiscal income of 902 Yuan per capita; 365 million output value of agriculture, forestry, animal husbandry and fisheries; farmers per capita net income of 4978 Yuan; total retail sales of 6.62 billion Yuan of social consumer goods.

To sum up, the whole planning area of Dianchi Lake Caohai realized a GDP of 42.689 billion Yuan the whole year, and to complete the local finance 1.478 billion Yuan,

agriculture, forestry and fishing output value of 539 million, total retail sales of 20.479 billion Yuan of social spending.

### 2.2.1.3 Land Use

According to the 2007 Caohai land-use maps, Caohai basin land area 195 km<sup>2</sup>, of which: arable land 25.73km<sup>2</sup>, take up 13.2%; vegetable land 6.28km<sup>2</sup>, take up 3.2%; a woodland 39.5 km<sup>2</sup>, take up 20.3%; shrub land 54.99 km<sup>2</sup>, take up 28.2%; grassland 1.93 km<sup>2</sup>, take up 1%; population, industrial and mining using land 59.82km<sup>2</sup>, take up 30.7%; lake water area 1.68km<sup>2</sup>, take up 0.9%; other land use 4.62 km<sup>2</sup>, take up 2.5%. As following we can see Figure 2-1.

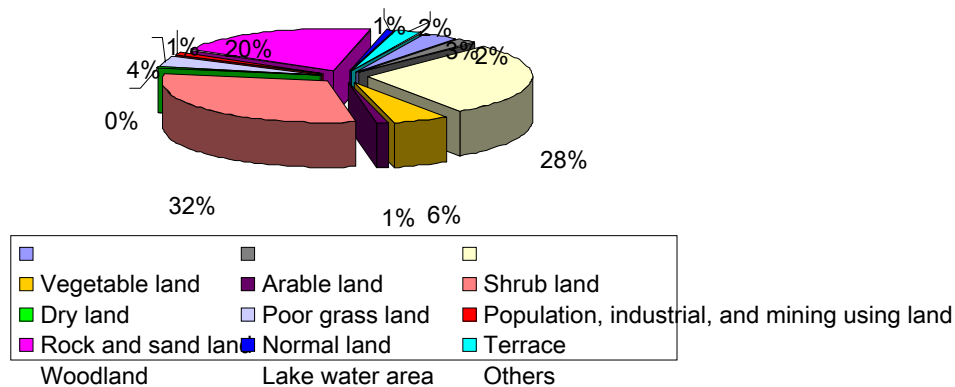


Figure 2-1.Land using of Caohai basin

### 2.2.2 Socio-economic Analysis

#### 2.2.2.1 Analysis of Caohai Valley's national economy

Based on the new adjusted data of Kunming administrative divisions, in 2007, Xishan and Wuhua areas' totaled GDP are 38.646 billion Yuan; in 2008 is 42.689 billion Yuan. The population of Caohai basin accounts for 25% of Kunming, while the GDP accounted for about 40% of Kunming, so it is obviously Kunming Caohai basin is in an important position of socio-economic development. Total retail sales of social consumer goods showed an upward trend, total output value of agriculture, forestry, animal and fishery showed a downward trend, it will shown in Figure 2-2.

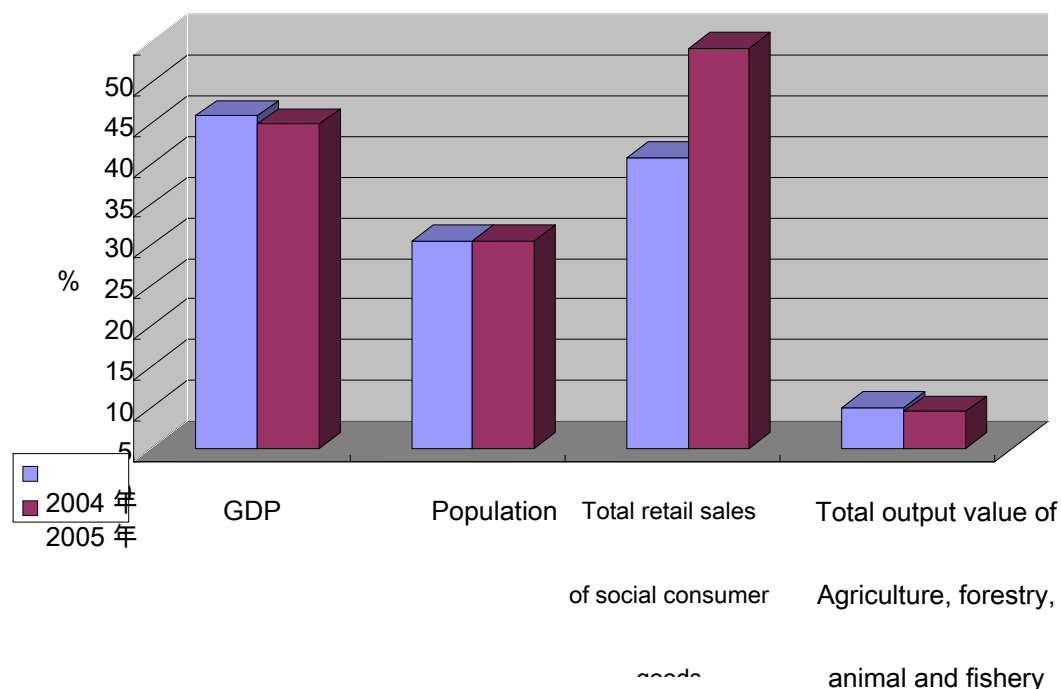


Figure 2-2. The economy development of Caohai Basin

#### 2.2.2.2 Industry Structure

With the rapid growth in economics of Caohai basin. The significantly increase of agricultural productivity, on the basis of steady development of agricultural, vigorously develop agriculture in peri-urban, there have initial success of facilities agricultural. In Industrial Area also get achieved remarkable results, secondary and tertiary industry is steady and healthy development, promoting the whole region's economic development as the main driving force. The tertiary industry growth rate significantly accelerated, and the urban services enhancements. We can clearly see the industrial structure shown in Figure 2-3.

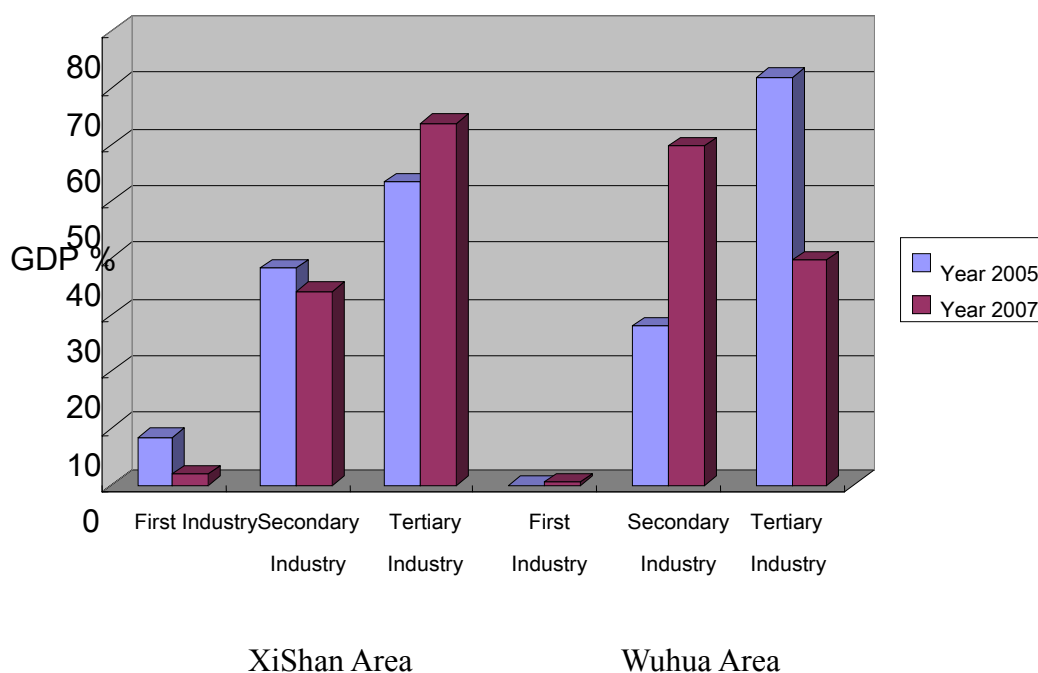


Figure 2-3. Industrial structure

### 2.3. Basin Water Environment System Analysis

#### 2.3.1 Analysis of Caohai's pollution sources

##### 2.3.1.1 Caohai basin pollution output

(1) The amount of pollutants pollution of city life

According to population calculations of 2007, Dianchi Lake Caohai Basin total population is 1.0695 million permanent residents, of which the household registration population is 727.7 thousand people, people who are living for more than six months non-permanent population is 341.9 thousand people. I1, I2, I3, I4 are Pollution Control District, the resident population is 988.6 thousand people, the pollutants pollution are mainly come from them. As following we can see population distribution in Table 2-3-1.

Pollution Control District	Basin Areas (km <sup>2</sup> )	Household registration population ( People )	Temporary registration population ( People )	Total amount of population ( People )
I1 Chuanfang River interflow watershed	8.96	228780	19735	248516
I2 Chuanfang River distributary watershed	10.60	28477	84391	112868

I3 Yunliang River interflow watershed	13.42	297177	63332	360509
I4 Yunliang River distributary watershed	58.42	112131	154657	266788
II1 Heilinpumian Mountain	50.55	42599	165	42763
II2 Xishamian Mountain	17.24	11462	306	11768
II3 Caohai East watershed	5.67	7038	19265	26303
<b>Total Account</b>	164.86	727664	341851	1069515

Table 2-3-1. Population distribution in Caohai basin

## (2) Pollution emissions from polluting industries

Polluting enterprises are located in I1, I2, I3, I4 Pollution Control District, the district pollution emissions are shown in table 2-3-4 and table 2-3-5.

Pollution Control District	Pollution water emissions amount ( 10000m <sup>3</sup> )	COD emissions amount ( ton )	TN emissions amount ( ton )	TP emissions amount ( ton )
I1 Chuanfang River interflow watershed Three types of industry	<b>143</b>	<b>331</b>	<b>20</b>	<b>1.8</b>
	109	281	15	1.7
I2 Chuanfang River distributary watershed Three types of industry	<b>24</b>	<b>26</b>	<b>4</b>	<b>0.2</b>
	23	25	4	0.2
I3 Yunliang River interflow watershed Three types of industry	<b>271</b>	<b>547</b>	<b>25</b>	<b>2.7</b>
	211	499	22	2.5
I4 Yunliang River	<b>357</b>	<b>412</b>	<b>33</b>	<b>0.9</b>

distributary watershed	28	53	1	0.1
Three types of industry				
Total Account	<b>794</b>	<b>1316</b>	<b>82</b>	<b>6</b>
Three types of industry	<b>371</b>	<b>858</b>	<b>43</b>	<b>4</b>

Table 2-3-4.

Pollution Control District	Pollution water amount		COD	TN	TP
	10000m <sup>3</sup> /year	10000m <sup>3</sup> /day			
I1 Chuanfang River interflow watershed	2139	5.9	4866	1027	93
I2 Chuanfang River distributary watershed	930	2.5	2086	461	41
I3 Yunliang River interflow watershed	3166	8.7	7126	1486	134
I4 Yunliang River distributary watershed	2499	6.8	5281	1114	98
Total Amount	8734	23.9	19359	4088	366

Table 2-3-5.

Total survey is 195 polluting enterprises, including 118 industrial enterprises, 77 enterprises of tertiary services industry. In 2007, sewage polluting enterprises amounted to 7.94 million cubic meters / year, of which tertiary services industry sector accounted for 46.8%. Chemical oxygen demand, total nitrogen and total phosphorus emissions were 1316 tons / year, 82 tons / year, 6 tons / year, and three production services accounted for 65.1%, 52.5%, and 79.8%. In the Pollution Control District area I1, I2, I3, the mainly industries are tertiary services industry, in the I4 Pollution Control District area, the mainly is industrial enterprises. We can compare Pollution Control District, industrial enterprises and the tertiary services industry, emissions in Figure 2-3-1.



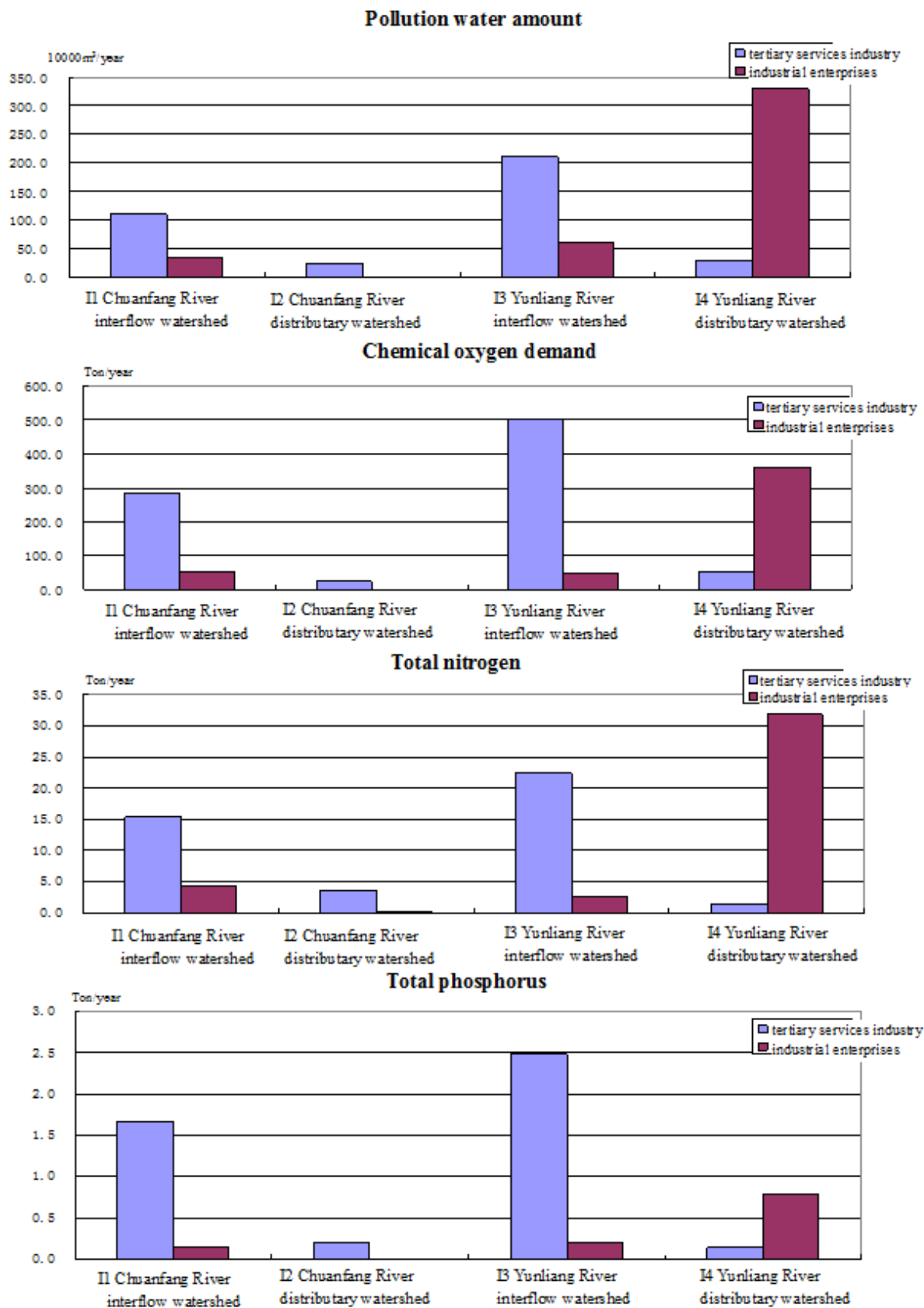


Figure 2-3-1.

2.3.1.2 Caohai basin to reduce the amount of pollutants

(1) Sewage Treatment Plant

There are currently have two sewage treatment plants in Caohai basin, first and third sewage treatment plant, designed to deal with the scale of 270,000 m<sup>3</sup> / d, in year 2007 the actual processing capacity of 242,000 m<sup>3</sup> / d.

(2) North Shore Sewage Interception Pump Station

In year 2007 North Shore Sewage Interception pumping station is normal operation, the ship room River Pumping Station pumping water total volume of 31.39 million cubic meters, cutting of pollutants into the lake of chemical oxygen demand, total nitrogen, total phosphorus, respectively 2458t, 434t, 55t.

As following we can see the situation of Caohai basin urban sewage treatment in table 2-3-6.

Sewage Treatment Installations	Actual Processing Amount ( 10000m <sup>3</sup> / year )	Treatment Amount ( ton )			Treatment Rate ( % )		
		COD	TN	TP	COD	TN	TP
First sewage treatment plant	3503	6591	635	103	92	60	86
Third sewage treatment plant	5328	8136	724	120	86	44	69
Chuanfang Sewage Interception Pump Station	3139	2458	434	55			
Total Account	11969	17185	1793	278			

Table 2-3-6. The situation of Caohai basin urban sewage treatment

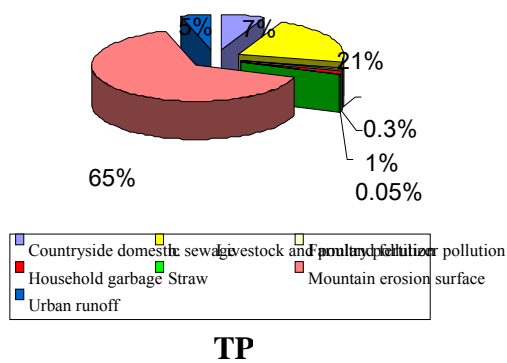
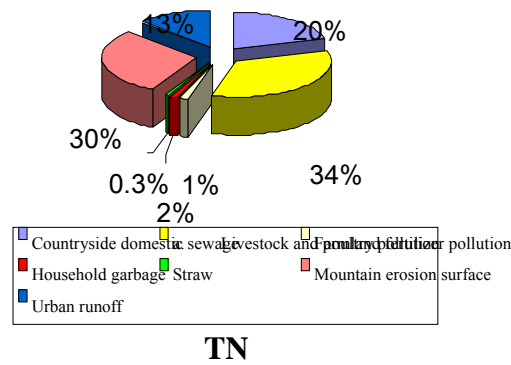
From the above table we can clearly see that the total cutting of pollutants into the lake of chemical oxygen demand, total nitrogen, total phosphorus, respectively 17185t, 1793t, 278t.

The pollution of Dianchi Lake has another important factor. Based on studies and research, Caohai basin source pollution including some of the rural domestic sewage, livestock breeding, agricultural chemical fertilizers, rural solid waste pollution, and urban surface runoff and Surface Mountain soil erosion, and so on.

As following I make a list of the urban pollution in Caohai basin.

- a. Countryside domestic sewage
- b. Livestock and poultry pollution
- c. Farmland fertilizer pollution
- d. Rural solid waste pollution
  - household garbage
  - straw
- e. Urban runoff
- f. Mountain erosion surface

Following Figure 2-3-2 will present the proportion of various types of pollution sources in Caohai.



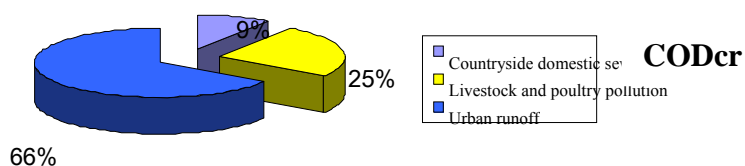


Figure 2-3-2. The proportion of various types of pollution sources in Caohai.

The pollution inside of Caohai Lake mainly refers to a large number of contaminated sediments into the lake formed by sediment contamination, in addition to the lake pollution, aquaculture and tourism pollution also infect the environment.

### 2.3.2 Pollution emission of Caohai

Based on the above data, Caohai Lake pollution were analyzed in 2007, major pollutants CODCr, TP, TN of the total respectively are 6454t, 152.2 t, 2543.6 t.

### 2.3.3 Analysis of Caohai's water environment quality

Caohai major rivers into the lake as following, Chuanfang River, Xiba River, Grand River, Wulong River, Old transportation River, new transportation River, and the Wangjia River, total amount is 7 rivers.

#### 2.3.3.1 The water quality status of Lake Inlet

Kunming Environmental Monitoring Center in 2007 has taken water quality monitoring of the seven major rivers into the Caohai Lake, the results showed that the seven rivers BOD5, CODCr, permanganate index, TP, TN, NH3-N, etc. of which 6 indicators exceed Class IV standard. BOD5, CODCr, permanganate content in seven rivers from serious to the light pollution is: Wulong River >New transportation River >Old transportation River >Chuanfang River >Xiba River >Wangjia River >Grand River; content of TP in rivers from serious to light is: Wulong River > New transportation River >Old transportation River >Chuanfang River >Xiba River > Grand River >Wangjia River; TN and NH3-N content from serious to light is: New transportation River >Wulong River >Old transportation River >Chuanfang River >Xiba River >Grand River >Wangjia River. Generally speaking, Wulong River, New River and the Old Transportation River's pollution is more serious, Grand River and Wangjia River are less contaminated.

#### 2.3.3.2 Water environment quality assessment of Caohai

According to June 2007 issued ("Yunnan Province of surface water environmental function zoning") by the Yunnan Provincial Environmental Protection Bureau, Caohai's water quality category Class is IV. According to the water quality monitoring results which was monitored by Kunming Environmental Monitoring Center in 2005 shows that, from the annual average terms, COD<sub>Cr</sub>, permanganate index, BOD<sub>5</sub>, DO, NH<sub>3</sub>-N, TN and TP and so on seven indicators, in addition to DO and high-potassium permanganate index not exceeding, other five indicators of the project exceeds Class IV; from potassium permanganate index, TN and TP monthly changes in circumstances, from June to October, the water quality is in low concentration, rest of the month are higher concentration of these index. We can see the change curve in Figure 2-3-3, Figure 2-3-4 and Figure 2-3-5.

2.3.3.3. Water quality dynamic assessment

In 60s the water quality of Dianchi Lake Caohai is grade II, 70s is grade III, after 70s until 80s the water quality gradually deteriorated into grade V. From year 1988 to 2007 the eutrophication phenomenon is more serious. In shortly 30 years, the water quality of Dianchi Lake is deterioration and fall 4 levels, Caohai abnormal eutrophication, local swampiness, lake water quality in a totally super-serious situation in the class V. From 1988 to 2007, the annual change of Caohai water quality COD<sub>Mn</sub>, TN and TP shown in Figure 2-3-6, Figure 2-3-7 and Figure 2-3-8.

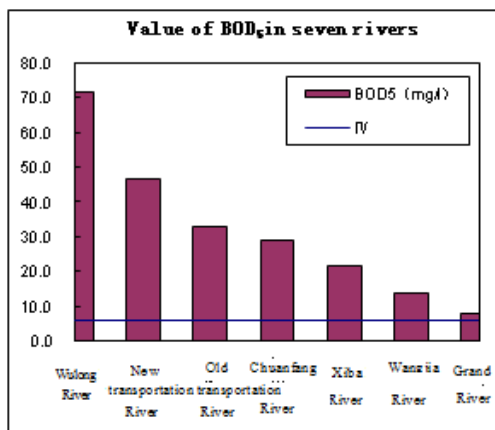


Figure 2-3-3

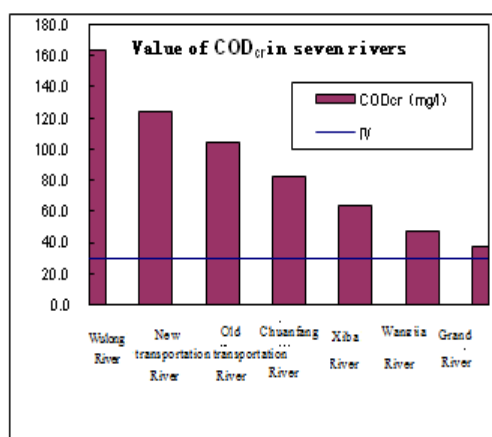


Figure 2-3-4

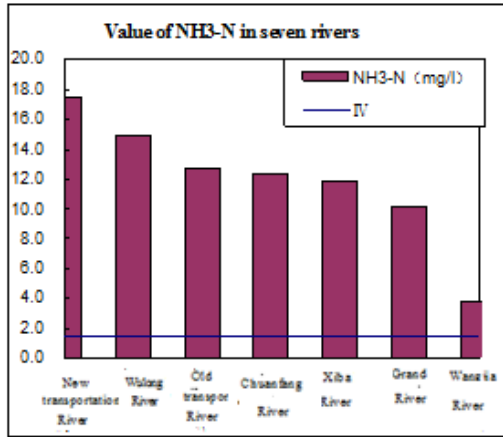


Figure 2-3-5

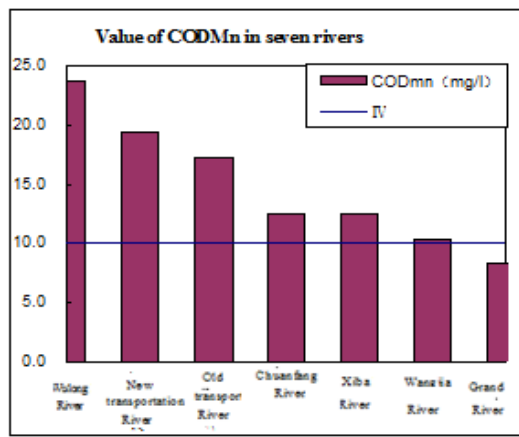


Figure 2-3-6

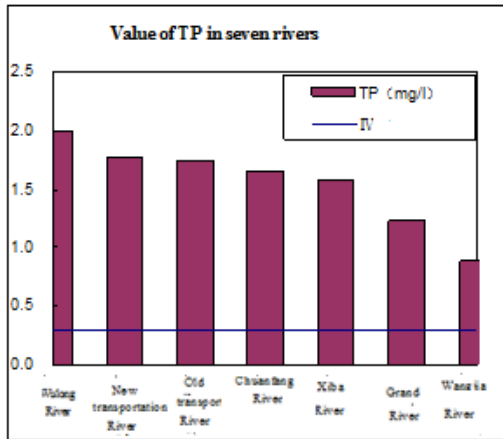


Figure 2-3-7

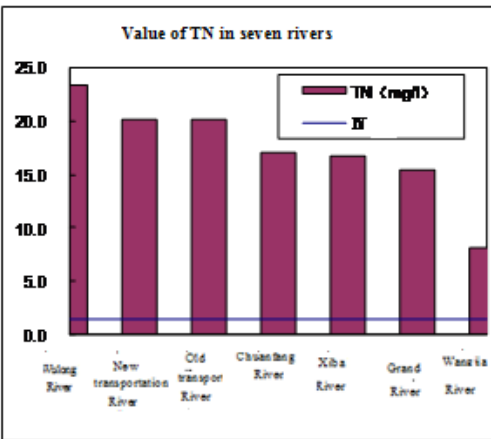


Figure 2-3-8

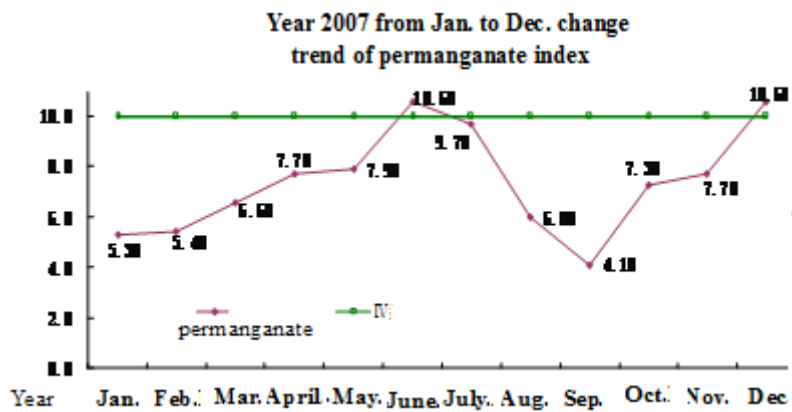


Figure 2-3-9

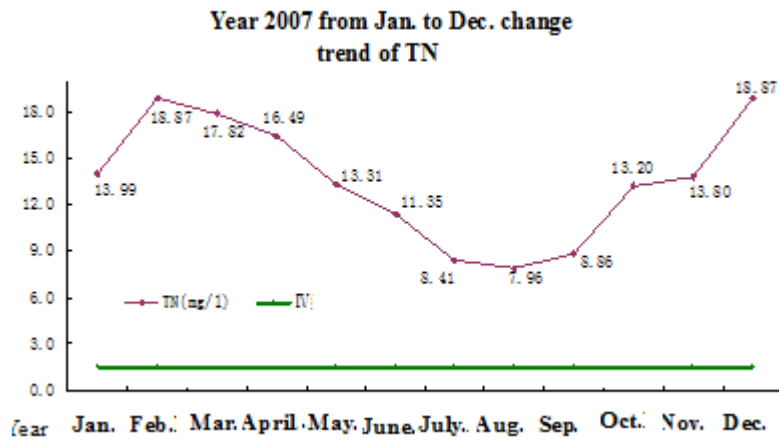


Figure 2-3-10

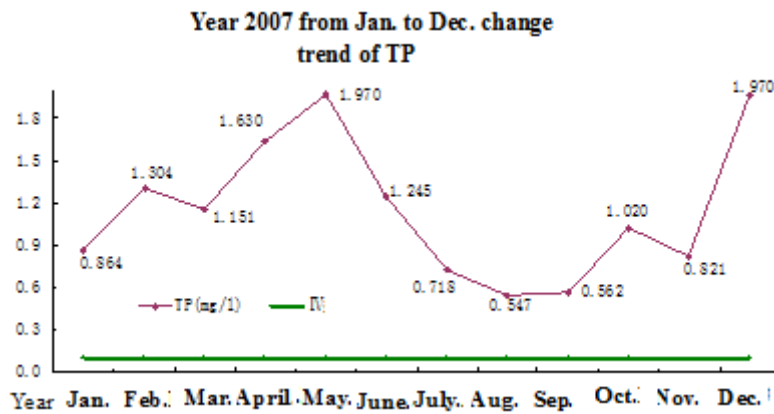


Figure 2-3-11

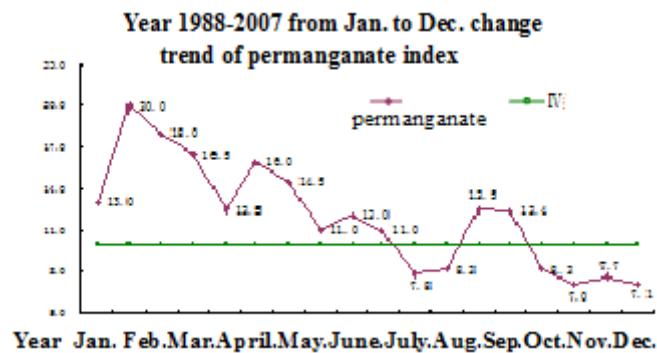


Figure 2-3-12

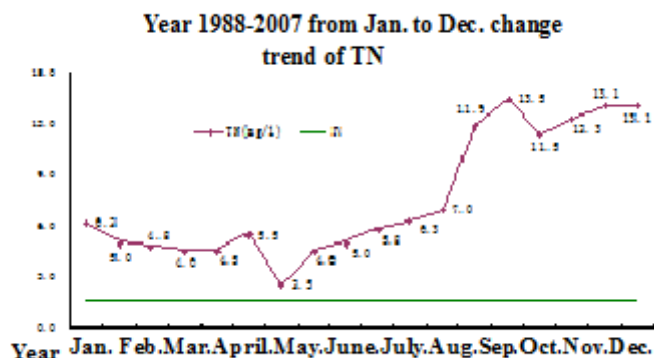


Figure 2-3-13

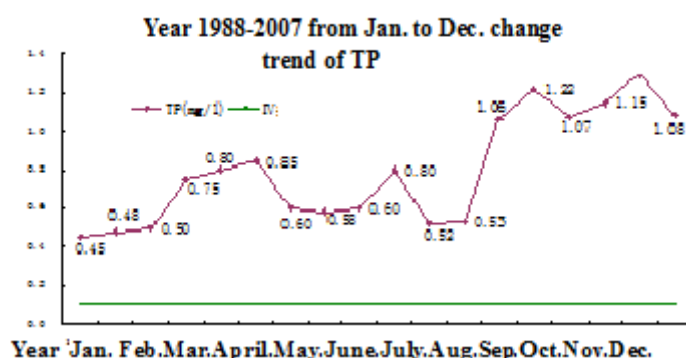


Figure 2-3-14

## 2.4 Watershed ecosystem analysis

### 2.4.1 Terrestrial ecosystem

According to topographic features, elevation and terrain conditions of Caohai basin, the planning area can be divided into mountains, plateaus, and lake area three landform types; corresponding to it, terrestrial ecosystems can be divided into forest ecosystem mainly of natural vegetation; agro-ecosystem, mainly vegetation is farmland; wetland ecosystems which is ecotone of water and land in lake area land; and of course there have urban ecosystem which is exist with the latter two systems, planning area basic types of ecological systems and characteristics shown in Table 2-4-1.

Types of ecosystem	Types of vegetation	Subtypes of vegetation	Basic Characters	Distribution Status quo



Forest Ecosystem	Evergreen Broad-leaved Forest	Semi-humid Evergreen Broad-leaved Forest	Floristic composition of China's Himalayan flora as a symbol, rich in (central Yunnan Plateau) special species	Around Xishan National Forest Park, Qiongzhu Temple Country Park, and Haiyuan Temple
	Deciduous Broad-leaved Forest	Warm Oak Leaf	Secondary vegetation living in good environment and moisture conditions	Ziwei village and Yuanshan slope
	Warm Coniferous Forest	Warm and Moist Coniferous Forest	Formed to secondary coniferous forest after disturbance by semi-humid evergreen broad-leaved forest	The upper reaches of Northeast Shahe reservoir
	Savanna Grass Irrigation	Warm and Wet Grass Irrigation of Savanna	After a long period of frequent interference with the formation of secondary vegetation	Wide area of face Mountain elevation 2000-2100m
Egro-ecosystem	Man-made Vegetation	Farmland Cultivated Vegetation	Slope flat land reclaimed as farmland, cultivated and domesticated vegetation	Distributing of Dayangtian, Ziwei village, Majie, Fuhaixiang
Urban Ecosystem	Man-made Vegetation	Landscaping	Building up of human material flow, energy flow, information flow fast-flow system, highly dependent on artificial regulation and control of natural, economic, and social complex system	Urban built-up area
Wetland Ecosystem	Aquatic Vegetation	Marsh	Subtropical floristic composition, large biomass, high-biodiversity	Mostly destroyed
		Eco-Freshwater		Water area of Caohai

Table 2-4-1. Planning area basic types of ecological systems, characteristics and distribution status quo

## 2.4.2 Aquatic ecosystem

### 2.4.2.1 The environment of river into the lake

Planning area is located in the Yangtze River, Pearl River and Red River watershed in the three river areas, well-developed of water network, but shortage of water resources. The distributed region have 7 rivers, they are Wulong River, Old Transportation River, New Transportation River, Wangjia River, Xiba River, Chuanfang River and the Grand River. Because of people environmental awareness is weak and urban development, planning area's good quality water are complete use as drinking water by the upper reaches of urban and rural residents, ecological and environmental water has been seriously impropriated, the river water supply is mainly urban sewage and rain water. In the river environment quality and quantity are difficult to get a better security situation, the influx of urban sewage, pollutants; high content of complex composition, resulting in Planning Area 7 river water pollution is very serious. According to Kunming Environmental Monitoring Central Station monitoring results, in recent years, into the lake Caohai's seven river water quality are inferior V class, major pollution factor is SS, NH<sub>3</sub>-N, TP, BOD<sub>5</sub>, COD, oil and so on, exceeding several times. Dark and foul river water led environmental change, biological extinction, the vast majority of biological loss of habitat, a serious loss of river ecosystems' biological diversity.

Water is seriously contaminated, at the same time, urban planning is not reserved for rivers ecological buffer zones, zoning and building are not regulations, they directly placed on the riverbank, river ecology has been seriously invaded and occupied, to change the natural form of the diversity of the river, river habitat condition worse. The survey, Wulong River, Old Transportation River, New Transportation River, Wangjia River, Xiba River, Chuanfang River and Grand River basically no clusters or blocks of aquatic and wetland plants distribution area, bio-habitat bad, aquatic life no survive condition, river ecosystems have been seriously damaged, the loss of ecosystem services, ecological security is threatened. The black and stinking river in planning area seriously affected the residents' lives and health, affecting the image of Kunming city.

### 2.4.2.2 Lake Ecological Environment

Caohai Lake environment has experienced three major ecological damage, especially in the last century 70's land reclamation, resulting in lake ecological environment of Caohai dramatic changes in ecosystem types, from land and water ecotone Lake ecosystem into farmland ecosystems, Subsequently, as the dramatic increase in population, with urban expansion and prosperity of watershed socio-economic, the land-use types of Caohai lake district again converted from agricultural land to construction land and residential areas, leisure areas, factories and enterprises using land, commerce using land, travel and tourism zones, and intertwine with the

farmland. Caohai natural lakeside wetlands disappeared, wetlands habitat no longer exists, the species and number of wet biology rare, indigenous fish species extinction, it is substantially reduce of genetic diversity, species diversity, community diversity, ecosystem diversity and landscape diversity. the ecological function is severely degraded.

But from year 2005, until now, through the construction of wetland restoration project to restore the project area aquatic habitats, vegetation restoration area is 96.8hm<sup>2</sup>, coverage rate reached 30.1%, land and water ecotone environment gradually formed the basic framework for aquatic ecosystems; create good conditions for further recovery of biological diversity.

## 2.5 River Basin Water Resources System Analysis

### 2.5.1 Water Resources Situation

#### 2.5.1 River Basin Water Resources Situation

Dianchi Lake Caohai Basin Water Resources total amount means the rainfall runoff and outside the basin water transfer and other human activities are affected by a variety of water into the basin combined. Whose sources include four parts: rainfall runoff, urban water supply, river basin water supply projects, urban sewage water and the water from sewage treatment plant.

##### 2.5.1.1 Rainfall Runoff

Caohai Lake's average volume is 86.4 million m<sup>3</sup>, in year 2007 the lake volume runoff is 92.62 million m<sup>3</sup>.

We can see runoff volume into the Caohai Lake in Table 2-5-1.

Unit: 10000 m<sup>3</sup>

Statistical Parameter			Annual Runoff Volume			
Average Value	C <sub>v</sub>	C <sub>s</sub> /C <sub>v</sub>	20%	50%	80%	95%
8640	0.30	2	10714	8380	6739	4838

Table 2-5-1. The total annual runoff volume of Caohai Lake

##### 2.5.1.2 Urban Water Supply

The water supply of Dianchi Caohai mainly from the Songhua dam, it is outside basin water supply. According to statistic of Kunming water supply company, in year 2007,

the total water supply amount of Kunming is 196.59 million m<sup>3</sup>, per capita daily water supply capacity is 304 liters / (person • day). Accordingly, in Caohai basin the total water supply amounted to 130.54 million m<sup>3</sup> in year 2007.

### 2.5.1.3 Caohai basin water storage project

Caohai basin currently built three small size reservoirs, they are West Baisha River, Ziwei village, and Sanjiacun reservoir, with a total storage capacity of the 6.42 million m<sup>3</sup>, Xingli reservoir capacity of 5.25 million m<sup>3</sup>, status of water supply capacity is 6.36 million m<sup>3</sup>, in year 2007 actual water supply capacity is 5.4 million m<sup>3</sup>, the main function of reservoirs is for urban water supply, agricultural irrigation and tourism landscape use of water. The basic conditions of reservoirs are as follows.

Project Name	Built Year	Total capacity of reservoirs 10000 m <sup>3</sup>	Xingli reservoir capacity 10000 m <sup>3</sup>	Status of water supply capacity of 10000 m <sup>3</sup>	Actual water supply in 2007 10000m <sup>3</sup>	Remark
West Baisha River,	1957	267	259	300	300	Agricultural irrigation and tourism landscape use of water
Ziwei village,	1978	105	99	129	90	Mainly urban water supply
Sanjiacun reservoir	1958	270	167	207	150	Mainly agricultural irrigation
<b>Total Amount</b>		642	525.2	636	540	

Table 2-5-2. The basic situation of the reservoir

### 2.5.1.4 Urban wastewater and sewage water treatment plant

According to the monitoring results of "The north shore of Dianchi Lake Water Environment Comprehensive Treatment Project", in 2007, the sewage water capacity directly into the lake is about 19.98 million m<sup>3</sup>. Measured results are shown in Tables 2-5-3.

Unit: 10000 m<sup>3</sup>

Name	New Transportation River	Old Transportation River	Wulong River	Xiba River	Chuanfang River	Total Account
Sewage water capacity	223	727	269	116	663	1998

Tables 2-5-3. Caohai major rivers into the lake water monitoring results

There have two sewage treatment plants surround Caohai basin, the tail-water enter through by Chuanfang River, Old Transportation River into Caohai. Excluding the

treated water by sewage treatment plant, each year there about 57.21 million m<sup>3</sup> of tail water into the Caohai.

### 2.5.1.5 Result Analysis

Urban water supply is outside water supply. Urban wastewater and sewage treatment plant tail-water in fact is the waste water after use into the Caohai, this part of the water through the water transfer project use for the agricultural and industrial recycling. As such as the watershed, its total volume of water resource is the sum of the rain water runoff, urban water supply and water storage projects. So we can see the results shown in Table 2-5-4.

Unit: 10000 m<sup>3</sup>

Projects	Hydrology Guaranteed Rate			
	20%	50%	95%	Status quo
Rain water runoff	10714	8380	4838	9262
Urban water supply	13054	13054	13054	13054
Water storage projects	636	636	646	646
Total amount	24404	22070	18538	22962

Table 2-5-4. Caohai Dianchi Lake Basin Total volume of Water Resources

### 2.5.2 Water Demand Analysis

#### 2.5.2.1 Integrated water consumption

In 2007, Dianchi Lake City per capita water consumption is 218 liters / (person • day), rural domestic water consumption is about 122 liters / (person • day). Caohai Dianchi Lake basin in 2007 the urban population 1.1277 million people, rural population is 48800 people (including the mobile population of 1.1765 million people), so we can estimate the integrated life of water using in Caohai basin is 91.9 million m<sup>3</sup>.

#### 2.5.2.2 Industrial water demand

According to EPA statistics, Kunming Dianchi Lake basin sewage of industrial enterprises report information, Kunming industrial output value of water consumption is 78m<sup>3</sup> / million, water consumption is 25.8m<sup>3</sup> / million. According to statistics provided by the 2007, (Kunming Wuhua and Xishan District provide) it statistics that in 2007 Caohai Dianchi Basin is 28.462 billion Yuan of industrial output value, it can be get that industrial water demand volume in this basin is 222.01 million m<sup>3</sup>, fresh water demand volume is 73.43 million m<sup>3</sup>.

### 2.5.2.3 Agricultural irrigation water demand

Based on satellite remote sensing imagery interpretation and statistical data, in 2007, cultivated land area of Dianchi Lake Caohai Basin is 3700hm<sup>2</sup>, accounting for the total land area 27%, mainly distributing in Caohai basin, and the upper reaches of the river is valley watershed. Winter and spring crops are irrigated agriculture, summer and fall crops as supplementary irrigation in agriculture, an integrated irrigation of farmland throughout the year take a higher quota. When water supply guaranteed rate is 85%, the status of irrigation water quota is 515m<sup>3</sup> / (mu • years). As noted in the irrigation water was calculated to 28.58 million m<sup>3</sup>. According to "Water Pollution Control of Kunming Caohai comprehensive feasibility study report" statistics, in 2007 Caohai water project for agricultural irrigation water is 11.5 million m<sup>3</sup>

### 2.5.2.4 Eco-environmental water demand

Dianchi Caohai Basin has many rivers, in order to maintain the ecological balance needed multi-year average runoff accounts for about 30% of the water as an ecological environment of water, so the Dianchi Lake Caohai basin's rivers ecological water environment is around 25.92 million m<sup>3</sup>. Dianchi Caohai basin eco-environmental water demand volume is about 65.92 million m<sup>3</sup>.

### 2.5.3 Analysis of river basin water resources supply and demand balance

Caohai Dianchi Basin in 2007 the water supply by itself was only 92.62 million m<sup>3</sup>, according to water pumping projects information statistics in 2007, the total quantity of water in Caohai is 157.3 million m<sup>3</sup>, it is difficult to maintain water balance of Caohai. From the current situation of water supply and demand, in the urban water demand is completely satisfied, and under the premise of the water, tail water discharged into the Caohai recycled, when the hydrology guaranteed rate of 50% there are still 30.2 million m<sup>3</sup> of water shortage, water supply and demand balance is depend on water supply outside of the basin, runoff water, sewage water recycling in Caohai's achieved, which constitute a greater pressure of Caohai water quality and watershed ecological environment, and also the main reason for the deteriorating water quality. Analysis showed that the Dianchi Lake Caohai Basin difficult to maintain their water balance, outside basin water supply, relying on Caohai as a loop to repeat the use of water in order to achieve water resources balance between supply and demand, in fact Caohai Dianchi Lake basin has been an imbalance between supply and demand of water resources, ecological environment water was used, caused serious damage of the ecological environment to the Dianchi Lake Caohai basin. We can see the analysis of water supply and demand in Caohai Dianchi Basin in 2007, it will be shown in Table 2-5-5.

Unit: 10000 m<sup>3</sup>

Year	Total volume	Supply Water
------	--------------	--------------

2007	of water demand	20%	50%	95%	现状
Urban life water use demand	9190	9190	9190	9190	9190
Agricultural irrigation water demand	2858	2858	2858	2858	2858
Industrial water demand	7343	7343	7343	7343	7343
Eco-environmental water demand	6592	6592	6592	6592	6592
Total amount	25118	24404	22070	18538	22962
Water resources supply and demand balance		-1578	-3912	-7444	-3020

Table 2-5-5 Caohai water supply and demand situation

## 2.6 Caohai pollution status assessment

### 2.6.1 Urban Wastewater Treatment Plant

#### 2.6.1.1 Status drainage system

Kunming, the main urban terrain is from north to south, the region from north to south into the rivers and flow into Dianchi Lake, Dianchi Lake become the only receiving water body of urban raining water. Currently the city has initially formed five main drainage systems, namely the North Area System, West Area System, South Area System, East Area system and the South East Area system. Status of the completion of the main city area is 180km<sup>2</sup>; the total pollutant wastewater treatment plant area is 87.58km<sup>2</sup>. Caohai basin have two drainage systems, including the West Area and South Area system,.

West area systems are located in the west of main city, including the western city and part of the West City Area. The status quo built-up area is 49.10km<sup>2</sup>, there have existing one sewage treatment plant and the pollutant area is 26.94km<sup>2</sup>.

Status polluted area is 49.58km<sup>2</sup>, built-up area is 36.88km<sup>2</sup>, the total pollutant area is 14.10km<sup>2</sup>. The status quo of two wastewater collection system in Caohai basin are

shown in the following table 2-6-1.

System name	Built-up area ( km <sup>2</sup> )	Pollutant Area ( km <sup>2</sup> )	Combined area where pollutant ( km <sup>2</sup> )	Length of sewage water tube ( km )	Combined length of tube ( km )	The size of Wastewater Treatment Plant within the system ( million
West Area System of city	49.10	26.94	10.5	86.5	94.58	15.0 ( Third )
South Area System of city	36.88	14.10	8.8	48.95	46.28	12.0 ( First )
Total Amount	85.98	41.04	19.3	135.45	140.86	27.0

Table 2-6-1 The status quo List Caohai basin sewerage system

At present mostly the drainage system was called as "Combined", it is based on the original agricultural irrigation canals and ditch system evolving evolution. River within the city have now basically cover to the conduit, becoming the confluence of the main sewer system in the urban areas. City has been built perfect system of piping system, but there still exist the phenomenon of sewage water mixed with raining water; the outskirts lack of proper drainage systems, sewage water and raining water drainage much more dependent upon natural drains.

## 2.6.2 Water control measures

### 2.6.2.1 Status of water resources evaluation of control measures

Water-control measures mainly through the regulation of upstream water storage and regulation of the downstream water engineering measures.

Has been the construction of upstream storage projects include the West Baisha Reservoir, Ziweicun Reservoir and Sanjia village Reservoir, with a total storage capacity of 6.42 million m<sup>3</sup>. This is built and put into use since the three reservoirs has been running well, in 2007 the upper reaches of the water supply to the Caohai 5.4 million m<sup>3</sup>, which solved the upper reaches water use of agricultural production and a small amount of drinking water problems in village, and also reduce flood protection



pressure of downstream during the rainy season.

Downstream water-control projects, in the annual rainy season from May to October will take 10 times of water resource deploy in Caohai basin, the project put into operation in 1996 to achieve the 11 years since the date, the results show that Each year, Caohai water resources' deploy is faster, shorter residence time, pollution load accumulation and substantial reduction, water quality improved significantly, particularly in water transparency significantly rising, so create a good ecological restoration of health conditions of Caohai basin.

#### 2.6.2.2 Problems

Caohai current regulation of water resources mainly for out water control, it through the works of downstream water-control projects, and the transfer is only one measure for Caohai runoff water resources, from local measures deployment of the water resources are no problem, but if we consider the replacement of Caohai water body, present is not perfect. As Caohai's water quality cannot meet the current requirements of water displacement, it must consider the import good-quality water from the outside to Caohai basin, with the attendant should also be considered a complete deployment of the measures

#### 2.6.3 Ecosystem restoration project

May 2003 ~ October 2007 the Government and the Yunnan Province, Kunming Environmental Protection Bureau jointly invested 26 million Yuan, has successfully implemented a comprehensive prevention and treatment of water pollution in Dianchi Lake, in the 15 projects including the Lake ecological restoration projects, to achieve Dianchi lakes Caohai back pond 3.3km<sup>2</sup>, built a good ecological environment of the Dianchi Caohai natural wetland ecosystem restoration project demonstration zone, Dongfeng Dam and veteran cadres in Caohai ponds of about 3.3km<sup>2</sup> surface of the water to achieve a different Vegetation types of large-scale aquatic plant community recovery is about 1km<sup>2</sup>, large-scale aquatic plant coverage of up to 30%; ecological zones of different vegetation types of large-scale ecological structure of aquatic vegetation to be established; were introduced more than 20 different aquatic plant species, 13 species of terrestrial plants, types of birds increased to 27 species, biological diversity significantly increased, lake ecological functions with the basic restoration, lake water and the natural environment has been significantly improved and beautified, to achieve the project target. This item was first implemented in the Dianchi lake scale ecological restoration projects, including the lakeside along with a basal scarp restoration project, ecological engineering of plants floating islands, rivers and canals into the lake pollution control projects along the lake with a large-scale aquatic plant community recovery projects, also Dianchi Lake Caohai history the same way, gradually restore lake benign ecological environment, improve the self-purification capacity of lakes to improve lake water quality and natural ecological

landscape, promote a virtuous cycle of lake ecosystems, will play an extremely important and irreplaceable role, and achieved a very good environment and social benefits of implementation of the project widened the Dianchi Lake, a prelude to ecological restoration project for the Dianchi Lake and ultra-eutrophic lake ecological restoration has provided valuable experience and great engineering example.

### **3. Caohai basin socio-economic development and pollution load forecasting**

#### **3.1 Trend forecast of basin population and socio-economic development**

##### 3.1.1 Population forecast

During these years, the city's security mechanism and social benefits of family planning-oriented mechanism has played an important role in the natural population growth rate continued to decline, from year 2000's 6.8 ‰ down to 6.23 ‰, under the "Kunming National Economic and Social Development Plan " the resident population in 2010 is expected to control the natural growth rate of 6.5 ‰ or less.

Population projections, including the total population, the resident population (including rural) and floating population projections (see Table 3-1), in which a total population is resident population and the floating population, therefore, only three of them need to use formula for prediction any two targets can be.

In the population projections, while we also need to consider the rural population factors of urbanization, because the needs of urban construction, due to the collective land has been completely lost their land after the expropriation of the rural population, and gradually transformed into urban residents, reflected in the dynamic process of change. During these years, Kunming Urban Construction and Development to adopt a new pattern, urbanization is accelerating, the urbanization rate (based on resident population) from year 2007's 57% guided rise to 60%. Caohai basin rural agricultural population in Kunming will be connected with the development of urbanization, according to 1.5-3% of the urbanization process will adjust the rural and urban population objective. Adjustment of the results shown in Table 3-1-1, 3-1-2, population trends see figure 3-1-1.

Population projections are calculated as follows:

$$P_i = P_{2007} ( 1 + r_i )^{t_i}$$

where :  $P_i$  - planning objectives, the population numbers;

P2007 - base year (2007) population statistics ;

$r_i$  - the average annual growth rate between planning target year and the base year;

$t_i$  - the time interval between planning target year and the base year.

Unit: person

Canton	Sub district offices	Year 2007			
		Total Population	Urban Population	Countryside Population	floating population
West Mountain Area	Jinbi offices	112807	102552	0	10255
	Yongchang offices	80739	41447	0	7340
	Qianwei offices	32832	2351	1279	2985
	Fuhai offices	85182	5212	8667	7744
	Zongshuying offices	69266	34888	0	6297
West Mountain Area	Majie offices	117731	44844	11367	10703
	Biji Town	4128	2375	1378	375
	Tuanjie Town	1403	195	1081	128
	Account	<b>504088</b>	<b>233864</b>	<b>23772</b>	<b>45826</b>
Wuhua Area	Huguo offices	96052	87320	0	8732
	Daguan offices	107072	97338	0	9734
	Huanshan offices	100589	91445	0	9144
	Fengning offices	92691	44203	0	8426
	Longxiang offices	55900	50818	0	5082
	Puji offices	110448	25339	18000	10041
	Heilinpu offices	109626	48561	7004	9966
	Account	<b>672378</b>	<b>445024</b>	<b>25004</b>	<b>61125</b>
Total Account		<b>1176466</b>	<b>678888</b>	<b>48776</b>	<b>106951</b>

Unit: person

Canton	Sub district offices	Year 2010			
		Total Population	Urban Population	Countryside Population	floating population
West Mountain Area	Jinbi offices	119699	105929	0	13771
	Yongchang offices	85672	42812	0	9856
	Qianwei offices	34838	3315	435	4008
	Fuhai offices	90386	11391	2945	10398
West Mountain Area	Zongshuying offices	73498	36037	0	8455
	Majie offices	124925	54199	3863	14372
	Biji Town	4381	3408	468	504
	Tuanjie Town	1489	951	367	171
	Account	<b>534887</b>	<b>258040</b>	<b>8078</b>	<b>61536</b>
Wuhua Area	Huguo offices	101920	90195	0	11725
	Daguan offices	113613	100543	0	13071
	Huanshan offices	106735	94456	0	12279
	Fengning offices	98355	45658	0	11315
	Longxiang offices	59315	52491	0	6824
	Puji offices	117196	38649	6117	13483
	Heilinpu offices	116324	55014	2380	13382
	Account	<b>713458</b>	<b>477007</b>	<b>8497</b>	<b>82079</b>
Total Account		<b>1248344</b>	<b>735047</b>	<b>16576</b>	<b>143615</b>

Table 3-1-1. Year 2010 Caohai basin population projection

Unit: person

Canton	Sub district offices	Year 2015			
		Total Population	Urban Population	Countryside Population	floating population
West Mountain Area	Jinbi offices	125829	109416	0	16412
	Yongchang offices	90059	44221	0	11747
	Qianwei offices	36622	3873	0	4777
West Mountain Area	Fuhai offices	95014	12830	1977	12393
	Zongshuying offices	77261	37223	0	10078
	Majie offices	131322	57380	2594	17129
	Biji Town	4605	3690	314	601
	Tuanjie Town	1566	1115	247	204
	Account	562277	269457	5132	73340
Wuhua Area	Huguo offices	107139	93165	0	13975
	Daguan offices	119431	103853	0	15578
	Huanshan offices	112201	97566	0	14635
	Fengning offices	103391	47162	0	13486
	Longxiang offices	62352	54219	0	8133
	Puji offices	123197	42133	4107	16069
	Heilinpu offices	122280	57686	1598	15950
Account	749992	495784	5705	97825	
Total Account		1312268	765241	10837	171165

Table 3-1-1. Year 2010 Caohai basin population projection

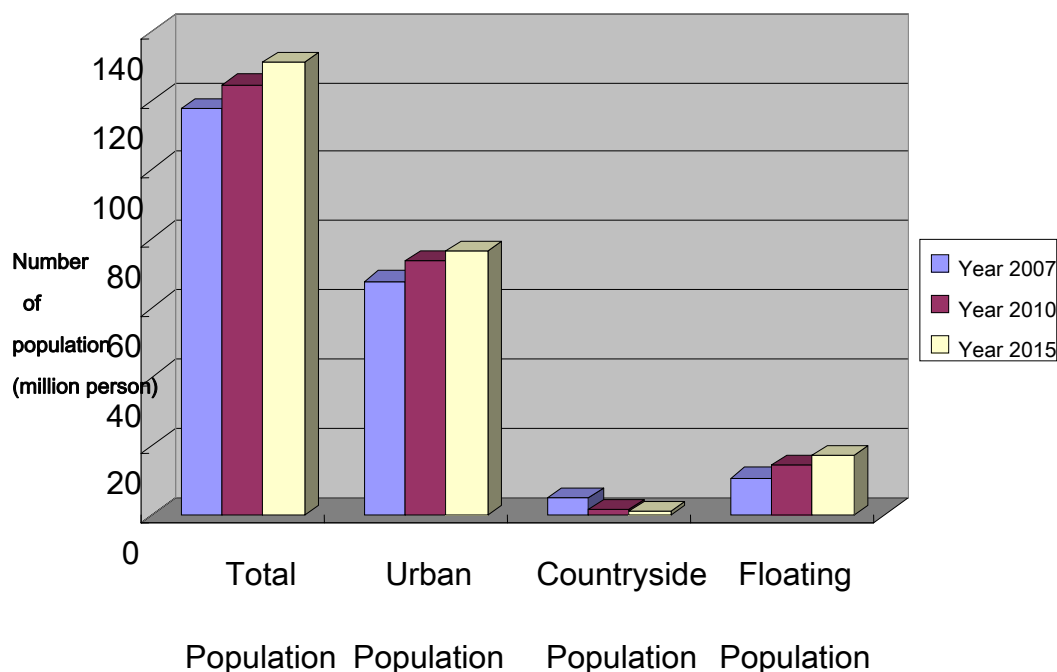


Figure 3-1-1. Population trends of Caohai basin

### 3.1.2 Socio-economic development forecast

During these years, the construction of modern new Kunming with the conditions for speeding up the development, the city's economic structural adjustment and economic growth patterns as the main line, in every respect will be a breakthrough, for the construction of resource-saving and environment-friendly society efforts. Kunming Dianchi Lake Caohai basin is located in the northeast of the main urban areas, involving Wuhua and Xishan Administrative Region, Caohai basin's socio-economic development is under the framework in Kunming the overall economic and social development reflects the economic development pattern and posture as following.

#### (1) Economic development

GDP average annual growth of 10%, per capita GDP (according to the resident population) average annual growth rate is 9%, in 2008 per capita GDP more than double of 2000.

GDP forecast formula is as follows:

$$GDP_i = GDP_{2007} (1 + r_i)^{t_i}$$

Where: GDP<sub>i</sub>-planning target year GDP;  
GDP<sub>2007</sub>-base year (2007) GDP Statistical;  
r<sub>i</sub>- the base year GDP planning target year between and average annual growth rate;  
t<sub>i</sub>- the time interval between planning target year and the base year.

Unit: 1/10 billion Yuan

Canton	Year 2007		Year 2010	Year 2015
	GDP	Per capita GDP (10000 Yuan)	GDP	GDP
Xishan Area	124.73	1.848	200.879	323.517
Wuhua Area	302.166	3.462	486.641	783.741
<b>Total Account</b>	<b>426.896</b>		<b>687.520</b>	<b>1107.258</b>

Table 3-1-3 Caohai basin Economic Development Forecast

## (2) The land use projections

In year 2007 the built completion of the main city of Kunming area is 212km<sup>2</sup>, in year 2010 main city urban scale will to be 220 km<sup>2</sup>, urban expansion based on the rate in 2007 increased to 3.8%; in 2015 the main city urban will scale to 247 km<sup>2</sup>, urban expansion rate basis on 2005 increase to 16.5%.

The urbanization processes in key areas are: Xishan area will focus on old villages; Wuhua Area will take Puji and Heilinpu Area as the focus Area, to greatly enhance the level of urban modernization.

## (3) Resources and the environment

Unit of GDP energy consumption decreased of 20%, environmental protection take place of GDP is more than 2%. The green space ratio in built-up area is more than 33%, the green coverage rate of built-up area is more than 36%, urban domestic garbage harmless treatment rate is over 80%, and urban sewage treatment rate is no less than 70%.

#### (4) The adjustment of industrial structure and layout

Macro-cluster development to promote competitive of industries, promote industrial development in the focus of the Chengong New Area, the airport economic zone, high-tech industrial development zones, economic and technological development zones, Anning Area, Northern Area, these 5 counties transfer to six major industries zone.

#### (5) Optimize the trade structure, enhance and build a modern system of commerce industry

In order to transform and upgrade traditional trade and commercial industries there have chain operation, logistics, distribution and circulation of e-commerce and other modern forms of organization. The main focus on 6 Commercial Street and nine commercial districts in First Ring Road, in Second Ring Road control the development of large shopping centers, warehouse-style shopping malls, large supermarkets and wholesale markets is the main target.

#### (6) Regional Integrated Development

To promote urban-rural integration, planning and construction of a number of central towns, the Center Village, the farmers to the cities or towns, land to the appropriate scale and concentrated. Play "lead" role of Wuhua District and Xishan Area to drive around economic development.

Wuhua District: Relying on the Central Business District to strengthen the modern service industry clusters.

Xishan Area: In accordance with the construction of modern new Kunming plans to seize the Industrial Park, Haikou, Yunnan Province, has been listed as key construction of industrial park favorable conditions, Xishan Scenic Area in the comprehensive development of ecological zones, we take the path of tourism resources and tourism environmentally sustainable development.

### **3.2 Watershed major pollution load forecasting**

#### 3.2.1 Pollution sources forecasting



### 3.2.1.1 Planning of the Town domestic pollution load forecasting

#### (1) Planning of annual equivalent population drainage projections

Built-up areas in 2010 Caohai basin covers an area of 96 km<sup>2</sup>, t annual equivalent population drainage projection is 990,000 people; in 2015 planned development area of 106km<sup>2</sup>, the annual equivalent population drainage will increase to 1.024 million people.

In Caohai basin annual equivalent population drainage projections will shown in Table 3-2-1.

Name of control area	Year 2010		Year 2015	
	Built-up area (km <sup>2</sup> )	Equivalent population ( 10000 people )	Built-up area (km <sup>2</sup> )	Equivalent population ( 10000 people )
I1 Chuanfang River interflow watershed	8.95	25.24	8.95	25.24
I2 Chuanfang River distributary watershed	10.60	17.03	10.60	18.02
I3 Yunliang River interflow watershed	13.42	30.10	13.42	30.10
I4 Yunliang River distributary watershed	62.62	26.63	73.26	29.04
Total Amount	95.59	99.00	106.22	102.40

Table 3-2-1. Annual population equivalent drainage projections

(2) The per capita pollution load forecasting

Based on "The main city of Kunming Drainage Master Plan revision" (2005-2030) and "Comprehensive management of water environment in Dianchi Lake North Shore Engineering Feasibility Study", planning a comprehensive domestic water in Kunming City and average displacement value shown in Table 3-2-2.

Year	Comprehensive domestic water ( Liter/people.day )	Urban wastewater emission factor	Comprehensive domestic sewage average indicators ( Liter/people.day )
2010	263	0.78	205
2015	274	0.78	214

Table 3-2-2 Comprehensive domestic water and drainage average indicators

Values of pollution load of pollutants per capita living in Kunming basis of the measured values with reference to the Chinese Academy for Environmental Planning recommended values and the well-developed urban per capita living at home and abroad pollution load indicators. The values are shown in Table 3-2-3.

Unit: grams / day. People

COD	TN	TP
60.0	13.0	1.1

Table 3-2-3 Pollution load of living pollutants per capita

(3) Life pollution sources and pollutants generated amount forecast

From the equivalent population projections and the value of per capita output of pollutants is calculated to life domestic pollution load. This takes into account the pipe penetration rate of 15%. The results are shown in Table 3-2-4.

Year	Area	Water Amount		Emissions ( ton/year )		
		10000m <sup>3</sup> /year	10000m <sup>3</sup> /day	COD <sub>Cr</sub>	TN	TP

2010	I1 Chuanfang River interflow watershed	2172	6.0	5528	1198	101
	I2 Chuanfang River distributary watershed	1465	4.0	3730	808	68
	I3 Yunliang River interflow watershed	2590	7.1	6592	1428	121
	I4 Yunliang River distributary watershed	2291	6.3	5832	1264	107
	Total Amount	8519	23.3	21681	4698	397
2015	I1 Chuanfang River interflow watershed	2267	6.2	5528	1198	101
	I2 Chuanfang River distributary watershed	1619	4.4	3946	855	72

	I3 Yunliang River interflow watershed	2704	7.4	6592	1428	121
	I4 Yunliang River distributary watershed	2609	7.1	6360	1378	117
	Total Amount	9198	25.2	22426	4859	411

Table 3-2-4 Caohai basin Life pollutant output value projections

## 3.2.1.2 Polluting enterprises emissions projections

From 2005 to 2015, is the peak of construction of modern new Kunming, according to "socio-economic development in Kunming," Kunming will taking industrial restructuring, Caohai Valley Industrial enterprises are mainly concentrated in the Kunming Hi-Tech Industrial Development Zone and Wuhua District of Puji and Heilinpu industrial zone.

Based on "the main city of Kunming Drainage Master Plan revision" (2005-2030) and "comprehensive management of water environment in Dianchi Lake North Shore Engineering Feasibility Study Report", the main city of Kunming's enterprises water use and comprehensive water use ratio is about 1:2.

This takes into account the pipe penetration rate is 15%. The average values of Kunming's enterprise water use and displacement are shown in Table 3-2-5.

Year	Average values of enterprise water use (liter/people.day )	Discharge coefficient	Enterprise Sewage Disposal average indicators (liter/people.day )
2010	64	0.78	50
2015	67	0.78	52

Table 3-2-5. The average values of enterprise water use and displacement indicators

From above result we can predict the produce value of industrial wastewater; the results are shown in Table 3-2-6.

Year	Area	Amount of water		Emissions ( ton/year )		
		10000m <sup>3</sup> /year	10000m <sup>3</sup> /day	COD <sub>Cr</sub>	TN	TP
2010	I1 Chuanfang River interflow watershed	469	1.5	852	65	3
	I2 Chuanfang River distributary watershed	316	1.0	575	44	2
	I3 Yunliang River interflow watershed	559	1.7	1017	78	4
	I4 Yunliang River distributary watershed	495	1.5	899	69	4
	Total Amount	1839	6	3343	255	14
2015	I1 Chuanfang River interflow watershed	487	1.5	885	68	4
	I2 Chuanfang River distributary watershed	347	1.1	632	48	3
	I3 Yunliang River interflow watershed	580	1.8	1055	81	4
	I4 Yunliang River distributary watershed	560	1.7	1018	78	4

	Total Amount	1974	6	3590	274	15
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Table 3-2-6. Caohai River enterprise pollutant output forecast

Forecast Year	Increase of water amount	Increase of the amount of pollutants ( ton/year )			Increase of water amount rate	Rate of increase of pollutants ( % )		
	10000m <sup>3</sup> /day	COD <sub>Cr</sub>	TN	TP	10000m <sup>3</sup> /day	COD <sub>Cr</sub>	TN	TP
2010	5.2	5665	865	45	21.5%	29.3%	21.2%	12.2%
2015	7.4	6656	1045	59	31.1%	34.4%	25.6%	16.2%

Table 3-2-7. Compared with 2007, the forecast of pollutants increase

### 3.2.2 Urban pollution sources forecasting

#### (1) The pollution of towns and villages of rural life

With the Caohai basin accelerated process of urbanization, the rural life of the main factors of pollution is improving living standards in rural areas and the pollution caused to demographic changes. Based on the projected 2010 and 2015's agricultural population, with reference to the relevant planning in Dianchi Lake in recent years to determine the 2010 and 2015, rural life in the basin wastewater discharge volume are 200L / d. people and 205 L / d. People in 2010 planning area of rural domestic sewage produced about 1.21 million t / a, sewage coefficient is 0.8, sewage discharge volume is 968,000 t / a. 2015 Planning Area rural sewage generated about 810,000 t / a, sewage coefficient is 0.8, sewage discharge volume is 648,000 t / a. The Pollution Control District and the sewage pollution load equivalent calculation results shown in Table 3-2-9, 3-2-10.

Pollution Control Area	The number of Agriculture Population ( people )	Emission coefficient ( g/person·d )			Emissions ( t/a )		
		COD <sub>Cr</sub>	TN	TP	COD <sub>Cr</sub>	TN	TP

I1 Chuanfang River interflow watershed	0	30	7.0	0.7	0	0	0
I2 Chuanfang River distributary watershed	435				4.76	1.11	0.11
I3 Yunliang River interflow watershed	0				0.00	0.00	0.00
I4 Yunliang River distributary watershed	12360				135.34	31.58	3.16
II1Heilinpi Area	367				4.02	0.94	0.09
II2Xishang Area	468				5.13	1.20	0.12
II3East area of Caohai	2945				32.25	7.53	0.75
<b>Total Amount</b>	<b>16576</b>				<b>181.50</b>	<b>42.35</b>	<b>4.24</b>

Table 3-2-9. Year 2010 predict the amount of pollution in rural life

Pollution Control Area	The number of Agriculture Population ( people )	Emission coefficient ( g/person·d )			Emissions ( t/a )		
		CODcr	TN	TP	CODcr	TN	TP
I1 Chuanfang River interflow watershed	0	30	7.0	0.7	0	0	0
I2 Chuanfang River distributary watershed	0				0.00	0.00	0.00
I3 Yunliang River interflow watershed	0				0.00	0.00	0.00
I4 Yunliang River distributary watershed	8299				90.87	21.20	2.12
II1 Heilinpi Area	247				2.70	0.63	0.06
II2 Xishang Area	314				3.44	0.80	0.08
II3 East area of Caohai	1977				21.65	5.05	0.51
<b>Total Amount</b>	<b>10837</b>	<b>118.67</b>	<b>27.69</b>	<b>2.77</b>			

Table 3-2-10. Year 2015 predict the amount of pollution in rural life



(2) Livestock and Poultry Pollution

According to the idea of development of urban animal husbandry, Caohai basin will stabilize livestock production; gradually raise the ratio of cattle, sheep and other herbivorous animals, so that the output value of animal husbandry accounted for about 30% of total agricultural output value increased to 40%. That means the pollution of livestock is simultaneous growth.

(3) Agricultural fertilizer pollution

The expansion of urban areas must make existing farmland reduced accordingly, will be to reduce fertilizer pollution of farmland. According to "Kunming Master Plan" land use forecast results, in 2010 Caohai basin farmland expropriated almost all the farmland fertilizer pollution can be ignored.

(4) The pollution of soil erosion prediction

With the development of industrial and agricultural production in Caohai, ecology environment through a series of ecological management measures will be improved, predict the results is basis of the status quo minus the status of after treatment to reduce the pollution load.

(5) Solid waste pollution load forecast

① Solid Waste

Based on the projected the agricultural population to carry out garbage of pollution forecasts of 2010 and 2015. The Pollution Control District, the pollution load estimates are shown in Table 3-2-11, 3-2-12.

Pollution Control Area	The number of Agriculture Population ( people )	Year emission ( t )	TN%	TP%	Emission ( t )	
					TN	TP
I1 Chuanfang River interflow watershed	0	0	0.4	0.1	0	0

I2 Chuanfang River distributary watershed	435	158.8			0.10	0.02
I3 Yunliang River interflow watershed	0	0			0	0
I4 Yunliang River distributary watershed	12360	4511.4			2.71	0.68
II1 Heilinpi Area	367	134.0			0.08	0.02
II2 Xishang Area	468	170.8			0.10	0.03
II3 East area of Caohai	2945	1074.9			0.64	0.16
<b>Total Amount</b>	<b>16575</b>	<b>6049.88</b>			<b>3.63</b>	<b>0.91</b>

Table 3-2-11. Year 2010 the amount of garbage generated and pollution load forecast

Pollution Control Area	The number of Agriculture Population ( people )	Year emission ( t )	TN%	TP%	Emissions ( t )	
					TN	TP
I1 Chuanfang River interflow watershed	0	0	0.4	0.1	0	0

I2 Chuanfang River distributary watershed	0	0.0			0.00	0.00
I3 Yunliang River interflow watershed	0	0			0	0
I4 Yunliang River distributary watershed	8299	3029.0			1.82	0.45
III Heilinpi Area	247	90.0			0.05	0.01
II2 Xishang Area	314	114.8			0.07	0.02
II3 East area of Caohai	1977	721.8			0.43	0.11
<b>Total Amount</b>	<b>10837</b>	<b>3955.54</b>			<b>2.37</b>	<b>0.59</b>

Table 3-2-12. Year 2010 the amount of garbage generated and pollution load forecast

## (6) Urban surface runoff

Comprehensive consideration Caohai basin City location, topographical features, amount of rainfall, non-agricultural population and area of built-up, water supply network coverage and other factors, according to city projections, the product of per unit area runoff coefficient COD<sub>Cr</sub>62 t/km<sup>2</sup>.a, TN<sub>1</sub>, 31t/km<sup>2</sup>.a, TP<sub>0</sub>,15t/km<sup>2</sup>.a, According to Caohai basin area of urban built-up areas, forecasting runoff pollution load. 2010 Caohai basin surface pollution load generation is COD<sub>Cr</sub>4855.8t / a TN of 102.6t / a, TP to 11.75t / a; 2015 the Town face pollution load generation is COD<sub>Cr</sub>6002.8t / a TN of 126.8t / a, TP to 14.52t / a.

(7) Total amount of source pollution output load forecast

Planning Year		Load (t)		
		CODcr	TN	TP
2010	Areal	6092.3	287.19	45.33
	Areall	738.8	307.39	143.37
	<b>Total Amount</b>	<b>6831.1</b>	<b>594.58</b>	<b>188.7</b>
2015	Areal	7493.07	340.23	54.79
	Areall	918	335.83	148.89
	<b>Total Amount</b>	<b>8411.07</b>	<b>676.06</b>	<b>203.68</b>

Table 3-2-13 Forecasting of the total pollution generate load

#### 4. Major environmental problems

- The pollution of Caohai is a difficult problem
- The main pollutants of Caohai are come from cities
- The main pollutants are transport by ship from separate tributaries to enter the Caohai
- The shortage of water resources are seriously polluted tributary
- Eco-systems have been broken, seriously affected the play of ecological service function
- Regulatory management are not perfect and may not be implemented

#### 5. Analysis of risk management and comprehensive benefit analysis

##### 5.1 Planning Risk Analysis

###### 5.1.1 Project Risk Analysis

In a market economy, because of the changing market conditions, increased competition may lead to poor decisions, management misconduct, allowing integrated

control of water pollution in Dianchi Lake Caohai planning projects to raise efficiency in the use of funds of great uncertainty, by produce a fund-raising venture. Financial markets are a place of financial intermediation, financial market volatility, such as interest rate, exchange rate movements, can lead to funding risk. The different sources of financing, the cost of financing, financing risks, the feasibility of financing are different, which requires all possible sources of funding after an assessment, in the debt structure of scientific planning of the cases, the combination of fund-raising channels and carrying out the capital structure decision-making to fully apply the principle of stability in order to minimize the risk of financing costs, and financing to ensure that the project is running to be the supply of capital funding. Financing risk analysis is the analysis of a number of risk factors in this combination under the influence of the estimated uncertainty of the future of this planning project financing may have adverse effects for the final assessment of integrated control of water pollution in Dianchi Lake Caohai Planning, Project Financing and right its risk management provide a scientific basis and reference. Use of financial investment and financing risks that may arise: First, tightening of macroeconomic policy risk. When confronted with tightening of macroeconomic policies, fiscal financing through integrated control of water pollution in Dianchi Lake Caohai planning projects, create difficulties in raising necessary, approval procedures are complicated and difficult to availability of funds. The second is less than the total investment risks. At present, the scale of urban construction and city growth, mainly rely on the Government to mobilize financial resources to meet market demand patterns to achieve. Relative to the requirements of rapid development alone fiscal integrated control of water pollution in Dianchi Lake Caohai planning the project total investment is still insufficient; leading to increased supply and demand has seriously affected the level of Regional Construction Caohai rapidly increasing. Third, the risks are lack of competition and incentive mechanisms. Financial credits as a foundation of government financing or financing channels both in the way the financing are subject to a large degree of restriction, which led to the existence of a public welfare project construction is very common, very prominent issue in the project construction period, the Government can in the project construction is often difficult to meet the financial funds needed for project funding.

Dianchi Lake water pollution prevention and control planning project Caohai large investment projects, implementation cycle is long, and there is market risk. Therefore, the need for funding and financing a variety of channels should pay attention to funding risks and operational risks improve management, optimize the organizational structure, to take the necessary measures to accelerate cash flow and improve fund use efficiency.

### 5.1.2 Risk management analysis

Integrated control of water pollution in Dianchi Lake Caohai the various projects planned project proposal, feasibility report or project plans are generally in a number of assumptions, the premise is forecast to be completed on the basis of these

assumptions, the premise is forecast during the project implementation the possible establishment, there may not be set up. Once the problem occurs, they are often resulting in project management side taken by surprise and without a response. In order to identify these conditions and the threat of hidden items, we need to project-related conduct a detailed review of various plans, such as contract of management plan, procurement program. From this we can conclude that management of risk assessment in general should pay attention to the following: the causes of the project, purpose, scope of the project, organizational goals and the relationship between project objectives, the project's contribution, the project conditions, constraints and so on. Management of risk identification on the one hand to use some common sense, experience, and judging by past experience accumulated project information, data, experiences and lessons learned, or consult the relevant experts and senior practitioners to discuss a collective approach.

Integrated control of water pollution in Dianchi Lake Caohai planning the implementation of various projects and management, are faced with how to determine the investment value of the project to assess the interests of the size, analysis of uncertainty, decided to invest in recovery time, and many other issues. Also, a plan for each project, regardless of their size, is bound to implement the parties in the management, operation and other aspects bring about change, which makes the project, would necessarily have high-risk characteristics. In particular, in recent years, the widespread implementation of various planning projects, on the one hand side brings a large number of project implementation management, management innovations, while the other hand, mortality, interruption, there are also many projects that fail. Therefore, how in the planning implementation of the project to effectively manage risk, control risk, this plan has become a necessary condition for the success of project implementation.

### 5.1.3 Risk Analysis of other irresistible

1. There still have natural and environmental risks. Natural and environmental risks, including floods, earthquakes, fires, typhoons, lightning and so is an irresistible force of nature, another unknown hydrological and meteorological conditions, complex engineering geological conditions, bad weather, the construction impact on the environment are all potential risk factors. Integrated control of water pollution in Dianchi Lake Caohai planning the implementation of various projects should take full account of these factors; the level of force majeure to be defined in the tender documents required the contractor to fully consider the impact of natural and environmental impact of the implementation of the project. On how to define force majeure is related to the implementation of the project in the risk-sharing is an important issue because the main risks arising from force majeure, including more than the contract level earthquakes, storms, rain, snow, and the tsunami and the special geological conditions are not predicted. In accordance with the general conditions of contract, such risks should be shared

- responsibility of the main contract, the contractor usually can only get the duration of the delay compensation.
2. Political and social risks. The political and social risks that many project managers in addition to urging a wealth of knowledge of the natural sciences need to have the political head. At present, the tender should assume the most popular political and social risks are relocation issues, carrying out the project in the city during the demolition of the problem due to delays caused by schedule abound. Engineering Extension enables people to bear the tender schedule delays and double the risk of construction delay claims. How to address the risks caused by the demolition of the need to tender the specific situation of people, specific analysis, properly addressed.
  3. Contractual risk. Construction project management contract is a legal document, but also project the main basis for comprehensive risk management. The project manager must have a strong sense of risk, in the drafting of contract documents have learned from the risk analysis and risk management point of view in terms of each contract, the project may face the risk factors are comprehensive and profound understanding. Otherwise, the risk of the project will bring huge losses.
  4. Design technical risks. Engineering design is leading the implementation of construction projects; there is no one perfect design, impossible to talk about tenders and contracts. Design changes are an important reason for claims caused by works, so the project should be complete prior to the tender design work. Only to avoid the uncertainty in the design of the program when the bidding, in order to avoid the resulting risk.
  5. Construction of technical risks. In the design of the program should be studied to determine the case of the implementation plan, because any construction plan can ensure that no changes and claims. Each implementation plan, whether it is traditional or newly created, has its own unique advantages and limitations. The owners must be risks in the construction plan be considered and evaluated. When the introduction of new construction methods and technology, engineering changes and would greatly increase the risk of claims, it must be based on the specific circumstances of the project to determine the appropriate construction programs.

## 5.2 Comprehensive Benefit Analysis

Water as a special kind of ecological resources, is supporting the entire life system, the material foundation for the Dianchi Lake area water shortages, more than 20 years, environmental pollution caused by runoff exacerbated by the scarcity of water, with the economic development and social progress and civilization, it is on the water environment functional requirements of various services, higher and higher, the water supply of the quality of environmental services and socio-economic development needs of an increasingly acute contradictions, Caohai basin water pollution control planning, implementation, these contradictions can gradually ease and restore ecological resources and proliferation of ecological assets to ensure sustainable

socio-economic development in Kunming, the benefit of future generations, their environmental benefits, social benefits and remarkable economic benefits.

### 5.2.1 Environmental benefits

Environmental benefits of this plan is mainly reflected in the following areas: Reduction of pollutants, reduce the environmental load of water catchment zone Caohai Dianchi Lake water pollution control planning, engineering, including comprehensive management of point source pollution projects, non-point source pollution in the comprehensive management of projects within the comprehensive management of point source pollution projects, water resources engineering, ecological restoration engineering and environmental supervision and management within and outside the comprehensive treatment project in Lake and measures for the implementation of this plan, most notably reflected in reducing the effects of the environmental effects of pollutants, the concrete embodiment in the following four areas:

Through the environmental supervision and management planning, implementation, from the source to reduce pollutants. The strengthening of environmental supervision and management capabilities to protect the watershed of industrial enterprises Caohai New Project Environmental Protection "three simultaneous" system, full implementation of the already completed the normal operation of water treatment facilities, water pollutant discharge standards, wastewater reuse, etc. Regular supervision and management of environmental protection laws and regulations and various policies to the letter; for new construction projects within the catchment to improve their access, through the implementation of environmental impact assessment system, a hedge against environmental pollution in the first place; for the Watershed District, diffuse sources of pollution, through publicity and education, strengthening management and governance at the end of the combination will be able to put an end to indiscriminate refuse, waste-water treatment dirt, pollution, environment, uncivilized phenomenon, reduction of pollutants generated from the source to achieve reduction of pollutants completely change the Caohai watershed dirty, chaotic, and poor state of the environment. With the people's production, living and consumption activities gradually standardized, resource-saving and environment-friendly society, the gradual establishment of river basin area will gradually into the environment clean, eco-OK ranks.

Through industrial point source pollution control projects, river training works, Sewage Interception pollution control project construction, industry, domestic sewage Interception rate of over 90%, to directly reduce the amount of pollutants into the lake: water volume of 1.48 million m<sup>3</sup> / a, COD<sub>Cr</sub>283t / a, TN 35t / a, TP4.2t / a; cut-point source pollution load; this plan is implemented, the water reuse rate, the amount of sewage produced less reduction in the pollutant. With the sewage treatment plant effluent for ecological water supply, not only to ensure the water needs of themselves



ecological projects, but also part of the sewage treatment plants purifies water depth. Ecological zones need to be cited 2.25 million m<sup>3</sup> / a sewage treatment plant effluent as irrigation water, ecological zones, this part of the water will not flow Caohai or disposal of land and then into the Caohai, according to the third sewage treatment plant effluent water quality, annual reduction of pollution load: COD<sub>Cr</sub>56t / a., TN 26t / a., TP2 t / a. Estimated annual pollution load discharged to the Caohai less about BOD<sub>5</sub> 3800 Dun, COD<sub>Cr</sub> 7200 Dun, SS 3600 Dun, TN 1000 Dun, TP 130 tons; to improve the boat room River, Wulong Caohai River and water quality, beautify the river environment on both sides, improve the quality of the environment, enhance urban flood control capacity.

Caohai basin after the completion of ecological restoration, the forest vegetation recovery will greatly improve the urban and rural ecological environment, enhance water conservation and reduce soil erosion; Watershed non-point source pollution reductions as follows: Mountain runoff pollution load reduction: COD<sub>Cr</sub> 95.3 t / a, TN 58.0 t / a, TP 8.1 t / a; farmland abandoned water 3.671 million m<sup>3</sup> / a, pollution load: TN 76.1t / a, TP 2.5t / a; Lakefront reduce non-point source pollution load of 35-75%, the lake can be reduced with a minimum of TN 46.9t / a, TP 3.7t / a. Ecological zone around the building will be Caohai 83.54hm<sup>2</sup> ponds into wetlands, not only eliminate the fish ponds on the Caohai pollution, while enhancing self-purification capacity of Caohai Lake band to become rain, abandoned farmland water purification main positions. Caohai ecological construction projects, including the Caohai Lake Estuary Ecological engineering and coastal wetland Caohai completed, Caohai lake with a total area of aquatic plants, restoration, Caohai Lake wetland ecology structure has been initially established, in Caohai around the main non-point source convergence zone formed lakeside green barrier, improve self-purification capacity of Caohai can further reduce non-point source pollution load of about 30%.

Endogenous pollution load reductions as follows: 3215.9 tons of total nitrogen, total phosphorus 512.8 tons;

In summary, through source reduction of pollutants, generated point source pollution reduction, non-point source pollution reduction, and four aspects of the endogenous control of pollutant reduction to achieve the grass, all aspects of water pollutant and the entire process control.

(2) The restoration of catchment areas of water environment function to ensure the protection of water quality goals of Caohai.

Caohai water pollution treatment project is implemented, an annual grass from overseas sources to reduce the amount of contamination: BOD<sub>5</sub> 3800 tons, COD<sub>Cr</sub> 7200 tons, SS 3600 tons, TN 1000 tons, TP 130 tons; in the amount of pollution sources: 3215.9 tons of total nitrogen, total phosphorus 512.8 t; with sea grass body replacement project, good-quality water annually transferred tons of water body to

achieve grass replacement times a year, through the integrated pollution control projects and water quality response analysis, in 2015 will be able to achieve the water quality Caohai reach "national surface water environmental water quality standard, to protect the water quality objectives Caohai.

With the Caohai pollution load reduction, biodiversity restoration, bio-food chain, repair and ecological functions of the growing strong, Caohai material circulation and energy flow will gradually smooth, this time, lake eutrophication process slowed down, algal blooms in occur will be significantly inhibited, water transparency will gradually increase, lakes to enhance self-purification ability, the landscape significantly improved. Beautiful highland lakes and mountains will be the leisure, entertainment, vacation, sightseeing, water sports ideal, Caohai turned into a real living room in Kunming city, the surrounding area of the Western Hills, Grand View Park, Dianchi Lake Holiday Resort, ethnic village, Haigeng Park and other scenic areas will further enhance the value of the mountain the United States, water, the United States, people more beautiful, Kunming city's image will be a new look.

(3) Increasing the watershed vegetation coverage, improve the ability to conserve water

Human intervention in forest vegetation, adjust the tree structure and improve forest quality, increase water resources, forest conservation rates on the Dianchi Lake basin more than 25 degrees slope of the land all the returning farmland to forest, 8-25-degree slope of the arable land to terrace, and the barren mountains of existing measures such as forestation projects, combined with planning area of road construction of forest networks, reconstruction Dianchi Lake Basin forest ecological barrier. Caohai water pollution treatment project is completed, the green screen area increased to Joe this plant as the main vegetation cover 55% of green coverage rate of 70% or more, the basic non-loess exposed to form, shrub and grass composition of multi-layer structure, and forest tree species within a reasonable structure, rich in biodiversity, regional water conservation large increase in capacity, reduction of small watershed flood peak and increase groundwater recharge dry season runoff, but also reduce the sediment into the river, to reduce non-point source pollution, reduce drought and floods The occurrence of water to ease tensions in Kunming, through the regulation of forest runoff water conservation, so that planning area rivers show clear easy, regular flow of seasons and beautifying the living environment and realize sustainable utilization of water resources.

After the completion of the project, according to land-water-300t / hm<sup>2</sup> terms, ecological zones protect water 59000 t; project area 364.15hm<sup>2</sup>, according to the surface coverage of 70%, erosion 1050t/km<sup>2</sup>.a, Caohai ecological zones years, and soil conservation capacity of 2676t; per ton of soil N, P content of 0.174% and 0.11% per annum respectively over Paul fertilizer N4.7t, P2.9t. According to the growth pattern of forest vegetation, in the biological control project after the completion of 15

years, through the eco-forest system, water conservation, soil conservation, Paul fertilizer, and effective control of soil erosion can be reduced at least annually, N, P into the lake pollution load N 3.5t, and P 2.2t.

(4) The rich biological diversity, maintenance of Caohai watershed ecosystem services

Caohai River Basin mountain greenery, the eradication of the barren hills and slopes, forest structure were modified to make more complicated, combining grass bushes and trees that the forest level, its soil and water conservation, water conservation of the ecological functions of greatly enhanced.

By river dredging, sewage interception, transformation and riverside embankments hydrophilic space construction projects to rebuild and restore the river ecosystem, improve self-purification capacity of rivers, crystal clear river water and river landscape on both sides for added luster to Kunming.

Caohai Lake wetland after the completion of flood storage capacity increased, the formation of the final Caohai a barrier to human production of renewable resources, gave rise to a unique entertainment, aesthetic, educational and research value.

With the Caohai reduce pollution loads, water quality improvement, and the gradual restoration of lake ecosystems, lakes and a variety of functions are gradually restored, Dianchi Lake, the people will be able to bid farewell to guarding a pool of sewage helpless embarrassment.

Caohai comprehensive treatment of water pollution after the completion of various projects, regional water environment and ecological environment will be greatly improved, the increase in green space and green system, the formation, so that recovery of biodiversity in the region with a carrier, a variety of species, breeding habitat After the formation of the environment, biological diversity will be gradually enriched, reflecting the Kingdom of colorful flora and fauna in Yunnan of biological landscape is possible become a reality.

Caohai water pollution control through the implementation of the project will be formed from the mountain to the entire watershed area Caohai land plants - aquatic series of distribution patterns, connected to the fault of ecosystem food chain, regional eco-system characteristics will be reproduced, eco - structure of the system become more complicated, to strengthen the eco-system stability and self-renewal, self-repair capacity, improve the eco-system anti-jamming ability, for life-sustaining substances in biogeochemical cycles, to maintain the hydrological cycle, maintenance of biological diversity, maintenance of Caohai watershed ecosystem services, maintenance of regional ecological safety, security, socio-economic aspects of sustainable development, and so plays an important role.

(5) Regulating climate, improving the urban atmospheric environment

Project after the completion of watershed green area will increase  $\text{hm}^2$ , a substantial increase in vegetation cover and its environmental benefits will be reflected in the regulation of large temperature and humidity to reduce dust pollution, absorb poisonous gases, killing the virus, reducing noise and so on.

Activities in the life of green plants, fixed atmospheric  $\text{CO}_2$  manufacturing plant organism, also released as a metabolite of  $\text{O}_2$ , to maintain the atmosphere enough  $\text{O}_2$ , to keep the air fresh. Leaf transpiration of plants can regulate the air temperature and humidity, absorb solar radiation, heat, lower surface temperature, according to the information reported, urban green space can reduce the ambient temperature 3-5 °C, an increase of 3% -12% humidity, shelter Yang Guan 60 % -94% of these environmental benefits of green plants to alleviate the urban heat island effect in Kunming.

Green dust and harmful substances are also significantly blocked by filtration and adsorption, on the one hand, the presence of trees reduces wind speed, wind speed of the slowdown in the wind particles reduced ability to spread. On the other hand, the forest canopy and the surface of the leaf, can suck dust lag, an initial estimate of the foliage area of trees is usually the sum of its area of 35-70 times a year per hectare, according to pine dust absorption capacity 26.4t calculation, Caohai basin new ecological forest is  $198.74\text{hm}^2$ , annual dust is 5210t.

We live in the atmospheric environment, usually contain 37 species of bacteria, 26 species of bacteria, 20 species of filamentous fungi and seven in the Bacillus bacteria, green plants by reducing dust, secretion restored onset of fungicide, kill or inhibit the virus in the atmosphere, Kunming garden widely used tree species, such as camphor, ginkgo, Yunnan Park, hanging-ling wood, cedar and so has a strong bactericidal ability.

(6) Rich architectural groups, contour, enhancing the townscape

Mainly of indigenous species, according to Caohai River mountains, rivers, lakes and features, give full consideration to topography, hydrological conditions, soil conditions, natural micro-climate and other factors, local conditions basin green Caohai built systems, keeping with the laws of nature and society, reflecting local characteristics and ethnic customs, is the construction of Kunming city a big step forward is a natural and man-made intervention in the perfect combination to build a green, rich urban landscape, enriched the connotation of urban architecture, to bring vitality to the city.

### 5.2.2 Social benefits

(1) Establish a city government accountable to the public interest, a new image Caohai water pollution control project implementation process, and indeed the main city of Kunming efforts to increase environmental protection, infrastructure investment, repayment of old debts the process of the project after the implementation of watershed smelly black water environment will be radically changed, will change the Dianchi Lake Governance "annual inputs, have not been effective," the passive situation, to achieve major breakthrough in Dianchi Lake governance, foster a good image of the government.

(2) To improve the living environment, construction, landscape garden in Kunming Lake City

Caohai water pollution with the gradual implementation of comprehensive prevention and treatment planning, basin water environment and ecological environment, the gradual recovery, the gradual expansion of green areas, urban forest park, shelter belts, green system and the gradual improvement of people to return to the natural landscape in Kunming At the same time, but also enjoy a variety of colors Kunming, plants, leaf color of plants, water features to display the "Spring City Flying Flowers are everywhere", Kunming City Environmental comfort level increases, UN-Habitat to further improve the environmental conditions, this process is also a landscape garden of Kunming Lake in urban construction process.

(3) Enhance the image of Kunming City, to boost its competitive edge Project implementation, the Caohai river water quality improved significantly, watershed ecology and hydrological system will enter a virtuous circle track, watershed ecological patterns, landscape pattern will become more orderly, and reproduce the beautiful mountains of the highland lakes area and beautiful, in a beautiful environment to live in Kunming people, care for the environment, love the enthusiasm of their homes will be further released, with the "Spring melt things and harmonious development; pioneers, the pursuit of excellence" in the same period in Kunming, the spirit of cultivated human who is the environment, each good image, the image of Kunming city and the people's spiritual outlook will be sublimated, and urban competitiveness further enhanced.

### 5.2.3 Economic benefits

(1) Direct economic benefit

Caohai the implementation of comprehensive treatment of water pollution, reduce the amount of pollutants into the lake, saving wastewater treatment investment, direct economic benefits.

Upon completion, the realization of urban water reuse, conservation of fresh water, with sewage treatment plant effluent to protect the ecological use of water, not only has a good environmental benefits, also in line with the principles of water conservation, while at current price of tap water (1.8 Yuan / t), after deducting the

total water demand in water treatment costs increase (0.8 Yuan / t), an annual water savings of 2.25 million, the annual water-saving value of 5.75 million Yuan.

Material production

Environmental Improvement

(2) Indirect economic benefits

Through the roads and sewage interception project, the ecological restoration and landscape works, a radical improvement in the Caohai ecological zones of the urban infrastructure and environmental conditions, become Caohai surrounding land development, land use, structural adjustment, and an important prerequisite for the construction of new city. Wuli Lake in Wuxi City, according to the experience of a beautiful environment will guide the construction of new urban areas of capital flows has greatly enhanced the price of land, resulting in enormous economic benefits, combined with the results of the Sunshine Coast auction block, after deducting fees and relocation of infrastructure cost is still about 30 billion in value-added space. As China's tourism capital city of Yunnan province, Kunming is the domestic and foreign tourists yearning for historical and cultural city, and numerous scenic spots and cultural relics, but Caohai is Kunming travel portal, is an important tourist attractions and places of entertainment, Grand View Park is the nation Village, cable, Xishan this golden tourist routes to pass. "Caohai ecological zone construction projects," the implementation of the formation and the natural forest and garden art as a whole eco-Lakeside Park, Lakeside residential areas, urban public services and supporting eco-tourism facilities, tourist attractions and promote the economic development of tourism in Kunming. According to the analysis project after the completion of the development of tourism brought about by the indirect economic benefits 12 million Yuan.

In addition, with the improvement of ecological environment of Caohai, regional comprehensive investment environment can be improved significantly, "the crosswise union," the basic conditions are guaranteed, and thus can promote the region as a whole social, economic and overall sustainable development, generated in the process of its development The economic benefits will be immeasurable, which is Kunming's rapid economic take-off is of great practical significance.

## 6. Conclusions

While people are recognized that the serious consequences of water pollution resources in rivers, lakes and other natural water resources, even we have been to proceed with treatment, but after all, people has to suffered a great loss, and will continue to pay a heavy price.

For the water pollution control, in my opinion, I have some special tips would like present as following, I hope it will be regarded by people and have some remarkable success.

1. Strengthen the protection of drinking water intakes

Relevant departments are going to draw drinking water area, set up signs in the region and to strengthen the water intake of the greening efforts. Regularly organize personnel to be checked. Fundamentally eliminate pollution, to solve the problem of purpose.

2. Increase the urban sewage and industrial wastewater treatment efforts To speed up the construction of urban sewage treatment plants to improve environmental conditions in our city water has a very important role. With the current urban population growth and living standards improve, the city's wastewater emissions are continuously increasing, while urban sewage treatment plants without a corresponding increase, which will inevitably lead to a decline in water quality. Therefore, construction of more sewage treatment plants is an urgent matter.

3. Strengthen the environmental awareness of citizens To improve the environment not only to control them, more importantly is through all aspects of publicity to enhance environmental awareness among the residents. If the residents' environmental awareness is increased, then the act of destruction of the environment is naturally reduced.

4. Achieve the water resource utilization With the development of economic, industrial wastewater emissions will also increase, if only attach importance to the end of treatment; it is difficult to achieve the purpose of improving the present situation of water pollution, so we have to achieve the water resource utilization.

“Caohai Dianchi Lake water pollution control plan” is in order to protect and improve the environment, in order to protect human health, to ensure the effective utilization of water resources and promote the development of socialist modernization. This is for our next generation, to create a good environment to live and cleaning water to use.

## 7. References

1. All of the materials are come from integrated control of water pollution in Dianchi Lake Caohai Planning, provide by Yunnan Provincial Environmental Science Research Institute.
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